SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME LVII NOVEMBER, 1933 NUMBER 5

HISTOLOGICAL GRADING IN CARCINOMA OF UTERINE CERVIX

ITS RELATION TO CLINICAL GROUPING AND PROGNOSIS

LOUIS H. JORSTAD, M.D., AND EUGENE S. AUER, M.D., ST. LOUIS, MISSOURI
From The Barnard Free Skin and Cancer Hospital

CONSIDERABLE interest has been aroused in regard to the significance of the grading of carcinoma since the publication of Broders' work in 1921. Other systems of grading have attracted attention; particularly the one devised by Schmitz and Hueper of Chicago, who are the authors of the so called "malignancy index." Probably no group of tumors have engendered so much difference of opinion as to the value of grading as the carcinomata of the uterine cervix. In grading our tumors, we have used the method of Broders to the exclusion of the Hueper method, for the reason that in the latter, the personal equation enters and carries too much weight in the result. Broders has arbitrarily divided tumors into four grades. The Grade I tumors are those containing from 1 to 25 per cent of undifferentiated cells. The Grade II tumors have from 25 to 50 per cent; the Grade III from 50 to 75 per cent; and the Grade IV from 75 to 100 per cent undifferentiated cells. A group of undifferentiated cells grow so evidently without restraint or self control, that the parent structure, whether tubule, layer, cord, or palisade, cannot be made out. Instead of differentiating into cells of parent type, they have embryonic characteristics. Such an area of undifferentiated cells has also been described as being made up of cells that have undergone de-differentiation or anaplasia. These terms signify the phenomena opposite to differentiation. It may be stated that a cell which goes through its life cycle and takes on the form of its parent, is a differentiated cell. Such a group of cells can be seen in the basal cell carcinoma, where we have a mass of cells, all of them being of the same structure as the basal layer of the normal epithelium. It is only the arrangement of these cells which distinguishes the mass from that of normal basal epithelium. Benign neoplasms, such as the myomata, manifest this same self control. Complete self control manifests itself in these neoplasms when degeneration sets in. The normal cells have ceased to regenerate and the remaining ones have differentiated beyond the point of regeneration. Complete differentiation is seen in the epithelial "pearle body." In very malignant tumors the regeneration of cells takes place so rapidly that very few, and occasionally none, of the cells differentiate.

Adverse criticism of grading is sometimes based on the fact that different grades are to be found in different portions of the same tumor. To meet this criticism, we have selected only the most rapid growing portion of such tumors as a basis in our grading. Adverse criticism is also based on the fact that at different periods of growth there is a difference in the grade of the tumor. This may

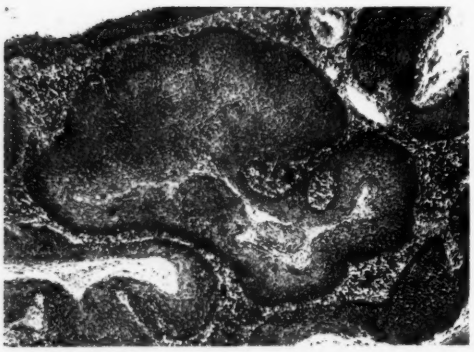


Fig. 1. Tumor tissue is made up of squamous cells with marked tendency to differentiation and characterized by lack of pearle formation. Less than 25 per cent of the cells are undifferentiated. Grade I.

Fig. 2. Keratinization and hyalinization are characteristics of this type of early and not extensive lesion. This represents a type as seen in the base of a cervical polyp. Grade I.

be due to the resistance of the host at varying periods of time. Additional adverse criticism is based on the personal equation. Whatever force there may be in this last objection, seems to be inapplicable to this study, for we have graded the tumors independently and yet have found less than 1 per cent difference of judgment covering 300 different specimens included in this study.

Some clinicians have attempted to formulate conclusions in regard to the prognosis of cervical (uterine) cancer, based on the results of numerous studies on grading of carcinoma of the lower lip. Such conclusions are open to severe criticism; in fact, it is impossible to use the lip as a basis of comparison for tumors of the cervix, simply on the assumption that in both instances we deal with surface epithelium.

In Table I a comparison is made of an unselected series of squamous cell carcinoma of the lower lip and squamous cell carcinoma of the cervix. It is clearly seen that the two sets of figures are entirely dissimilar. No one has ever reported such a high percentage of cures in cervical cancer as these figures show to be possible in lip cancer (reported by Jorstad from this hospital in 1930).

It is believed, and quite well authenticated, that tumors of Grade I, being comparatively slow in growth, metastasize much later than

Fig. 3. The usual cellular differentiation, cellular infiltration, vascular changes, and keratinization in this grade and type of malignancy are shown. Grade I.

TABLE I.—CARCINOMA OF LOWER LIP

Grade of malignancy	% living and well 5 years	% of total cases in each group
I	80	26
II	76	49
III	60	22
IV	∞	3

CARCINOMA OF CERVIX

Grade of malignancy	% living and well 5 years	% of total cases in each group
I	66	1.3
II	14.5	51.3
III	18.6	44.5
IV	14.2	3.0

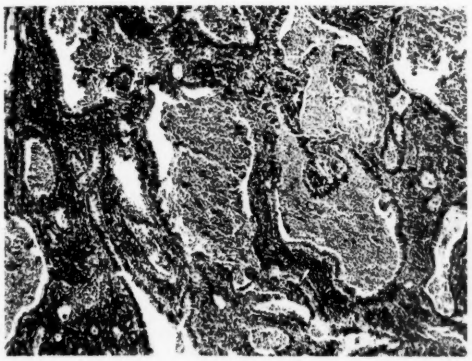


Fig. 4. The type described in Figure 1, almost one-half of this tumor being undifferentiated. The polypous arrangement is definite. Grade II.

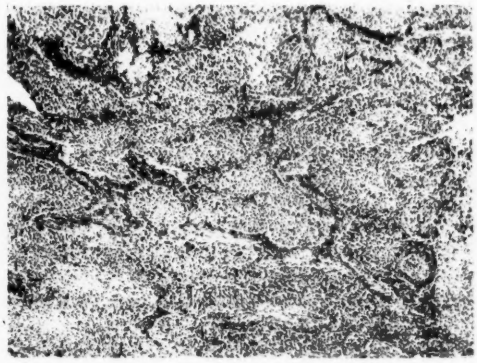


Fig. 5. This typifies a tumor with less differentiation than the same type of tissue shown in Figures 1 and 2. Grade II.

the less differentiated types of tumor. In cancer of the lip we see 26 per cent of all cases in Grade I, whereas but 1.3 per cent of the cervical cancers are thus grouped. From the 5 year results in cancer of the lower lip, it would seem that knowing the grade of tumor with which the surgeon is dealing, he must allow this knowledge to influence greatly his prognosis, even though a standard radical procedure of removal or destruction is done in each case. This is not true of the cervix series. In each case we are seemingly dealing with similar squamous cell carcinomata microscopically, but the clinical picture is entirely dissimilar. Early carcinoma of the lip is a common clinical diagnosis, but early carcinoma of the cervix is decidedly an uncommon diagnosis on our histories. A relatively late cancer of the lip with metastasis to the regional (submaxillary and submental) lymph nodes leads to a guarded prognosis; about 25 per cent 5 year cures result in a series of properly treated cases. But when the jugular chain of nodes becomes involved, the percentage of 5 year cures falls to 10 per cent and below. This group now becomes equivalent to the cases of cancer of the cervix coming to us, which we clinically group three (according to the Schmitz classification). Remembering this fact, we are in a position properly to analyze our figures, and realize that no direct comparison should be attempted between carcinoma of the lip and cervix.

In Table II we have arranged all cancers of the cervix, treated by radium *alone*, into clinical groups as well as microscopic grades.

TABLE II.—SQUAMOUS CELL CARCINOMA OF THE CERVIX

Clinical group	Histological	Cases	Length of life after treatment
I	Grade II	3	82 months
	Grade III	2	72 months
	Grade IV	1	15 months
II	Grade II	4	53 months
	Grade III	6	60 months
III	Grade II	19	29 months
	Grade III	19	30 months
	Grade IV	3	44 months
IV	Grade II	46	17 months
	Grade III	45	9 months

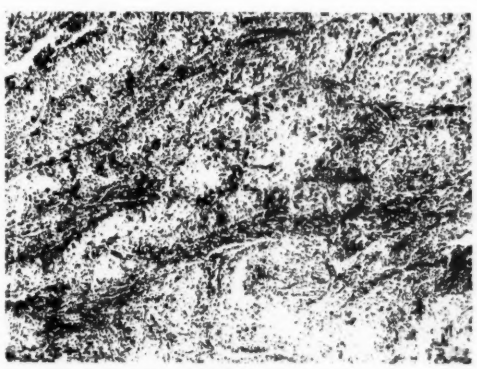


Fig. 6. The usual architecture seen in these tumors. At least 25 per cent of the fixed tissue cellular structure is differentiated. Grade III.

Fig. 7. A good example of an almost completely undifferentiated tumor with typical stroma. Grade IV.

Fig. 8. Attempts at differentiation are noted, but the cellular structure and relationship places it in this group

We have used the clinical grouping of the Schmitz classification.

Briefly, the Schmitz clinical classification divides cancer of the cervix into groups as follows:

Group I. Malignancy is confined to the uterine cervix.

Group II. Malignancy has spread to the adjacent vaginal wall.

Group III. Uterus is still movable, but there is beginning thickening of one or both broad ligaments.

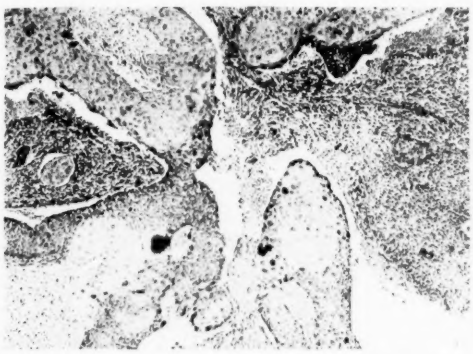
Group IV. Uterus is fixed.

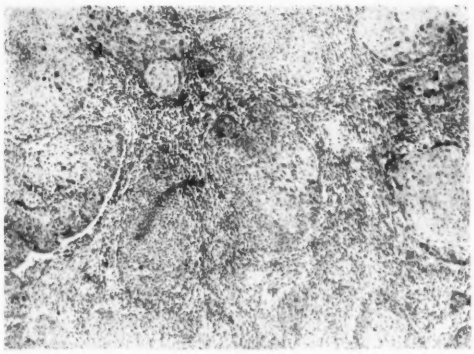
Observing the Table, it is at once obvious that we have no Grade I cases in any clinical group. The reason for this is that all the Grade I cases were found in Groups I and II, and these being considered operable, had surgical treatment. We have included in this series only those cases that received radium or X-ray therapy; no case treated by surgery alone, or a combination of surgery and radium, is included. Furthermore, no case was considered which could not be traced to the time of death, or found living after 5 years. It is only by such measures as these that statistics of this nature become of value. From a study of this chart, it seems evident that: *Clinical grouping and extent of disease is more important than grading from a prognostic standpoint.*

Do these figures signify that grading is of no value whatsoever in the study of cervical cancer? We do not believe they do, for there are facts that are not shown in the figures. It has been our observation that the immediate effect of radium on the more undifferentiated type of tumors is greater than on the differentiated types. We find greater immediate retrogression in Grades III and IV, than in Grades I and II, the clinical extent of involvement being approximately the same, and a like dosage of radium being applied in each case. This is added evidence of the greater radio-sensitivity of Grade III and IV tumors.

From the purely morphological standpoint, there are two types of squamous cell carcinomata of the cervix. The type which may undergo keratinization "pearle formation" is the more usual type. Eighty per cent of the neoplasms in this series are of this type, the four grades being typified in Figures 3, 5, 6, 7, and 8, respectively. The other type does not show this tendency to keratinization when undergoing the varying degrees of differentiation. It somewhat resembles the structural makeup of a basal cell carcinoma; however, the squamous type of cell is easily made out (Figs. 1, 2, and 4). As a matter of interest, one of the specimens in this series was made up of a mixture of the two forms (Figs. 9 and 10).

It is also our observation that rectovaginal and vesicovaginal fistulæ occurred almost always in carcinoma of the Grade III and IV variety after treatment with radium. This fact becomes more significant when it is known that the radium dosage was approxi





Figs. 9 and 10. The tumor tissue is made up of two types of squamous cell carcinoma, as depicted separately in Figures 1 and 3. Two tumors in our series presented these histological features.

mately the same in a large majority of the cases treated, so that it could not be by but mere chance that the fistulæ occurred in the less differentiated types of tumor alone. Therefore, it is safe to assume that patients with vaginal involvement with carcinoma cannot with safety receive the same radium dosage, regardless of the grade. The Grade I or II carcinoma will withstand a greater dose with less danger of perforation than will the Grades III or IV. Some Grade I or II carcinomata are so radio-resistant that a combined radium dosage of 7,000 milligrams given over a relatively short period of time has caused little retrogression clinically, and yet we were dealing with a relatively slow growing neoplasm. We unfortunately know from experience the disastrous results to the bladder and rectum that such a large dosage of radium causes when applied to the more rapidly growing, more radiosensitive, undifferentiated tumors.

From an analysis of the grading of all the cervical cancers treated by radium in this hospital, from 1917 to 1927, it can be concluded that grading alone is of no prognostic value. Due to the concealed location of the tumor, and the absence of early subjective symptoms in the majority of cases of cancer of the cervix, it is impossible to formulate ideas in regard to these neoplasms on the basis of conformity with similar neoplasms of the lower lip. That grading is or may be of great value in the radium treatment of a specific case of carcinoma of the cervix is true; furthermore, grading may be the deciding factor in the decision to employ surgical treatment rather than radiation, or vice versa.

REFERENCES

1. Broders, A. C. J. Am. M. Ass., 1920, lxxiv, 566; Path. & Lab. Med., 1926, ii, 376.
2. Hueper, W. C. Arch. Path., 1928, vi, 1064.
3. Jorstad, L. H. J. Cancer Research, 1930, xiv, 295.
4. Schmitz, H. Radiology, 1927, ix, 322.

CEREBRAL HEMIATROPHY WITH HOMOLATERAL HYPERTROPHY OF THE SKULL AND SINUSES[1]

CORNELIUS G. DYKE, M.D., LEO M. DAVIDOFF, M.D., F.A.C.S., AND CLEMENT B. MASSON, M.D., F.A.C.S., NEW YORK

THE size and shape of the skull is usually dependent upon the degree of development of the brain. Moreover, these qualities of the skull, and presumably also of the brain, vary according to race, individual inheritance, and often national custom. What happens to the skull, then, if the brain, through injury or disease, suffers a loss of substance? In the course of our examination of many encephalograms, a number of cases have come to our attention in which, following trauma to the head, or disease of the brain at birth or during early childhood, not only does the brain show evidence of marked atrophy and hypoplasia, but the skull presents changes that can be interpreted only as secondary phenomena in response to a diminution of the intracranial contents. In the present study we are confining ourselves to a consideration of those patients in whom these changes in the brain and skull are for the most part unilateral and relatively well marked. A report of 9 cases is included.

LITERATURE

Clinically the patients belong to the group usually called "infantile hemiplegias." The literature on this subject is very extensive and deals with its every phase. There are many discussions, especially of the pathological findings in the brain, the peculiar character of the hemiplegia, the nature of the convulsions, and the trophic changes in the hemiplegic extremities. It is also well known and mentioned by most authors that the bones of the face, often including the orbit, show on the hemiplegic side a retarded development which is looked upon as part of the general retardation of growth on that side due to loss of trophic control by the contralateral cerebral hemisphere. Concerning the bony abnormalities of the skull on the side of the affected hemisphere, however, relatively few references are available.

A thickness of the skull on the side of the brain lesion has been remarked upon by several authors such as Guénau de Mussey (1830), Bell (1831), Turner (1856), and S. Van der Kolk (1861). Cotard (1868), in fact, was aware not only of this thickening, but, in so far as the more or less incompletely studied post mortem material permitted, of a dilatation of the frontal sinuses as well. He states: "In the majority of cases the diminution in the capacity of the skull occurs by the retraction of the internal table without any notable deformity of the exterior of the skull. The thickness of the bone becomes augmented. In some cases the bones appear to be blown up, the orbital roof becomes doubled into two layers between which are found large cells which appear to be expansions of the frontal sinus."

Peterson and Fisher, in 1889, reported the cranial measurements in 20 cases of infantile hemiplegia. They concluded that in all their cases there was not only a diminution in all dimensions of the skull and its capacity, but that there was an additional diminution in the size of the skull on the side opposite the paralysis.

Freud, in his classical monograph on "Die Infantile Cerebrallaehmungen" (1897) gives the most complete summary of the literature on this aspect of the problem. His opinion is worth quoting since it represents the essence of the conclusions reached not only up to his time, but to this very day. He says: "The undoubted interrelation between the growth of the brain and the overlying parts of the skull is apparent in numerous ways in the cerebral hemiplegias." The skull seems to profit, according to him, by the release from pressure of a growing brain and becomes thickened over areas where the brain is sunken in. The inner table appears heaped up and the "orbital cavities as if blown up" (quoting Cotard). In other cases, he observes, there is an inhibition of growth of the skull corre

[1]From the X-Ray and the Surgical Departments of the Neurological Institute of New York. Presented before the New York Neurological Society, October 4, 1932.

sponding to the affected hemisphere, the vault fails to develop, or there may even be a depression. Sometimes, indeed, in post-traumatic cases, an actual defect in the bone exists. All these changes, however, are inconstant and are to be expected most often in children whose illness begins early in life.

Oppenheim declares that "changes in the bones of the skull, depression, defect-formation (porocranii), diminution in circumference, hypoplasia of the vault upon the side of the brain lesion, form an inconstant symptom."

Déjerine, too, says that "one sometimes finds a flattening, even a depression, of the vault of the skull at a point corresponding to the cerebral lesion, especially when porencephaly is present, but this finding is not constant."

Peritz, in the new edition of his book, refers to "growth disturbances" in the skull in infantile hemiplegia, without describing them.

In the numerous comprehensive monographs on the subject of infantile hemiplegia, little comment is to be found on the skull changes that we have been able to demonstrate on the roentgenograms. The explanation probably lies in the fact that many of these monographs were written prior to the introduction of roentgenography and that recent studies lay so much stress on cerebral pathology as seen in the pneumoencephalograms that the abnormalities of the skull in roentgenograms receive scant attention.

CASE REPORTS

CASE 1. Eileen S., N. I. No. 9020H, aged 23 years, admitted to Institute June 22, 1931. Severe illness with fever at 14 months, accompanied by convulsions and a left hemiplegia which have continued to date. Hypertrophy of the skull, sinuses, and mastoid on the right side; dilatation of the right lateral ventricle; displacement of ventricles to right.

Complaint. Nervousness and irritability, convulsions and left sided weakness.

Present illness. The patient is one of five children. She was born without difficulty and remained in apparent good health during her first year of life. At 14 months, she is said to have had an acute illness accompanied by high fever which was thought to be "infantile paralysis." Convulsions occurred at this time and a paralysis of the entire left side was noted. The left side of the mouth and both eyes were "crooked." After recovery from the acute illness, convulsions recurred once annually until the age of 5 when they began to take place monthly and became more severe. This has continued up to the present time. The seizures have been mostly nocturnal and have been generalized in character. The patient's health has been good otherwise. She reached the seventh grade in school but has never worked because of deformity. Her past and family history are of no importance.

Physical examination. The patient is a well nourished and well developed young woman but for the left extremities which are underdeveloped. She is nervous, irritable, and reserved, but seems mentally normal. The left side is spastic, with exaggerated reflexes and a positive Babinski and confirmatory signs. She also has a left hemihypæsthesia. The examination is otherwise negative.

Laboratory findings. Negative[1].

Roentgen-ray examination. The plain films of the skull show a marked thickening of the right half of the frontal bone. The right ethmoid and frontal sinuses are greatly enlarged and extend laterally and backward, to include the anterior clinoid process. There is overdevelopment of the right mastoid and extensive pneumatization of the petrous portion of the right temporal bone (Fig. 1).

Encephalograms show the bony changes described above, and in addition a dilatation of the right lateral ventricle with a shift of the entire ventricular system toward the right side displacing the midline structures of the brain to the right. It is apparent that the right side of the cranial cavity is much smaller than the left. The sulci markings are practically absent over both cerebral hemispheres (Figs. 2 and 3).

Although the illness that initiated the present condition was obscure in nature and was probably not "infantile paralysis" as suspected at the time, it was apparently an infectious process of the brain affecting a hitherto normal infant. The right sided cerebral atrophy was anticipated clinically, but the accompanying right sided hypertrophy of the skull and sinuses was unexpected as characteristic associated findings.

CASE 2. Lena L., N. I. No. 7014H, aged 19 years, admitted to Institute January 12, 1931. Onset of right sided paralysis and sensory Jacksonian seizures after febrile attack at 1 year; right homonymous hemianopsia; mental retardation. Thickening of bones of left side of skull; overdevelopment of left ethmoid and mastoid cells; dilatation of left lateral ventricle; displacement of ventricles to the left. Operation disclosed a markedly degenerated, sclerotic left hemisphere.

Complaint. Paralysis of the right arm; pain in right side of the head.

[1]Laboratory examination in these cases consisted of routine blood and urine examination, blood Wassermann, and spinal fluid: cells, globulin, total protein, Wassermann, and colloidal gold test.

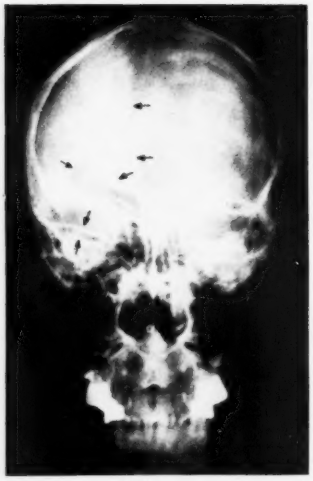


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. Case 1. Anteroposterior roentgenogram showing marked thickening of the right side of the skull, with overdevelopment of the right ethmoid cells and hyperpneumatization of the right petrous ridge. Arrows point to the thickened bone, the enlarged right ethmoid cell, and the aerated petrous ridge.

Fig. 2. Case 1. Anteroposterior encephalogram showing the dilatation of the right lateral ventricle with displacement of the ventricular system toward this side, also the changes seen in Figure 1. Arrows point to the unilateral thickening of the skull and overaeration of the petrous ridge.

Fig. 3. Case 1. Lateral encephalogram showing the extensive aeration of the superior orbital plate, including the anterior clinoid process on the right, due to an extension laterally of the ethmoid cells. Note the marked thickening of the right half of the frontal bone and the dilatation of the right lateral ventricle.

Present illness. The patient was the third child in the family, born normally at full term, weighing 9 pounds. She was in good health and developed normally until 12 months of age when she was taken suddenly ill with high fever. That night she had a convulsive seizure beginning on the right side and becoming generalized. Such convulsive attacks recurred at intervals until the age of 3 years. After the first seizure, the baby began to rely on her left arm and hand, the right remaining almost entirely useless. Gradually the paralyzed upper extremity began to turn in at the wrist, and as time went on, its development, as compared to the left, became retarded. Involvement of the right lower extremity was not evident. Between the ages of 3 and 16 she was in fairly good health. Mentally she was somewhat backward, having reached only to Grade 8A when she left school at 17.

When 16 years of age, she began to have a new type of seizure. This begins with a "gripping pain" in the right temple which lasts from 3 to 10 minutes and leaves her feeling very weak. The pain is accompanied by a sensation of numbness in the right arm, and numbness and weakness in the right leg. Sometimes the right side of the face also feels numb and speech becomes difficult. All these associated signs outlast the pain in the temple, as a rule, by several minutes. These seizures occur at intervals but appear on the average of once in 3 days.

Physical examination. The patient is a well nourished, mentally retarded girl of 19. She limps in walking owing to weakness and underdevelopment of the right lower extremity. The right arm is also weak and hypoplastic. The entire right side is spastic with increased reflexes, but with an absent Babinski reflex. A complete right homonymous hemianopsia is present.

Laboratory findings. Results of all clinical laboratory tests were within normal limits.

Roentgen-ray examination. There is marked thickening of the left side of the skull, especially of the parietal and temporal bones. The left superior orbital plate is much thickened by the formation of cancellous bone between the outer and inner tables and pneumatization by the overdevelopment of the ethmoid cells. There is also thickening of the left anterior clinoid process and the left sphenoidal ridge. The mastoid cells on the left are overdeveloped and have pneumatized the petrous portion of the temporal bone (Fig. 4).

Encephalograms show a dilatation of the left lateral ventricle with a shift of the ventricular system toward the left, and a definite decrease in the capacity of the left side of the cranial cavity. No sulci markings are present over the upper half of the left cerebrum. Coarse sulci markings are visible in left lower frontal and temporal areas; normal sulci markings seen over right cerebral hemisphere (Figs. 5, 6

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 4. Case 2. Anteroposterior roentgenogram showing the increased thickness of the left side of the skull. The pneumatization of the left petrous bone is well seen in this view.

Fig. 5. Case 2. Anteroposterior encephalogram showing the enlargement of the left lateral ventricle and the displacement of the entire ventricular system to the left. There is an absence of sulci markings over the upper half of the left cerebral hemisphere, while in the temporal region the cortical markings are coarse. Note also the thickening of the skull on the left and the pneumatization of the left petrous pyramid.

Fig. 6. Case 2. Postero-anterior encephalogram showing the enlargement of the left lateral ventricle and its displacement to the left. The pneumatization of the petrous pyramid is well shown in this view.

Operation. At another hospital a left osteoplastic flap was turned down with considerable difficulty owing to the thickness of the bone, which measured 1.5 centimeters in some areas. The brain showed generalized atrophy with narrow convolutions and widened sulci. Faradic stimulation of the motor area produced no reaction. The cerebrum was tough, resembling cartilage in consistency. A small piece of cortex was removed for biopsy. Histological examination of this tissue showed marked gliosis with practically no ganglion cells.

As in the previous case, the onset was signalized by an acute febrile episode in infancy, which was accompanied by generalized convulsions. These convulsions continued to be generalized in character in spite of the presence of a hemiplegia, until she was 3 years old. It is to be noted that a latent period existed between the ages of 3 and 16 years during which she was free from seizures of any kind. The present attacks, which began at 16, have a definitely focal character.

The roentgenograms show changes strikingly similar to those of the first case and in retrospect, the clinical picture in this case might have been predicted from the appearance of the roentgenograms even without the aid of air injection.

Case 3. Jeanette S., N.I. No. 12539H, aged 14 years, admitted to Institute May 17, 1932. Fall at age of 1; frequent minor seizures; occasional generalized convulsion; mental deficiency; right hemiparesis. Thickening of left side of skull; hypertrophy of left frontal, ethmoid, and mastoid cells; dilatation of left lateral ventricle; shift of ventricles to left; decreased capacity of left side of cranial cavity.

Complaint. "Nervousness and spells."

Present illness. This patient is an only child, delivered through a cæsarean section. She was well until 1 year of age when she fell from a perambulator to the sidewalk, striking her head severely. She had an immediate "shaking spell," followed by a "convulsion" which lasted almost all night. High fever was present for about 3 days. She remained in a hospital for 2 months, and when she was brought home, the parents found that the right hand and arm were drawn across the chest and one of the legs could not be used well. Ever since then, she has had frequent spells of unconsciousness lasting 2 to 3 minutes. When she grew old enough to describe these spells she began to complain of dizziness, a peculiar taste which she identified with bread, and "haziness" of vision. In addition to these spells, she had isolated severe convulsive seizures at the ages of 5 and 10. The child was late in walking

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 7. Case 3. Anteroposterior encephalogram showing a definite enlargement of the left lateral ventricle and a slight shift of the entire ventricular system to the left. Note again the thickening of the left side of the skull.

Fig. 8. Case 4. Postero-anterior roentgenogram showing the increased development of the left frontal and ethmoid sinuses. The arrows point to the slightly pneumatized left petrous pyramid and to the overdeveloped left ethmoid cells.

Fig. 9. Case 4. Anteroposterior encephalogram showing asymmetrical enlargement of the lateral ventricle, more marked on the left. There is also a slight shift of the ventricular system to the left. Some thickening of the skull is present bilaterally but more marked on the left.

and talking and has shown mental deficiency since early childhood.

Physical examination. The patient is well developed and well nourished. There is a hemiparesis and hypoplasia of the right side of the body. The reflexes are increased on the right, and there is a questionable Babinski sign on the right. She has a scoliosis of the thoracic spine with the convexity to the right and a right talipes cavus. On Terman test she shows a mental age of 8 years and 8 months with an intelligence quotient of 59.

Laboratory findings. All clinical laboratory examinations on the blood, urine, and spinal fluid were negative.

Roentgen-ray examination. The skull on the left side is definitely thickened. The left ethmoid and frontal air cells are hypertrophied. The left petrous ridge is pneumatized by an extension into it of the mastoid cells.

Encephalograms show a dilatation of the left lateral ventricle and a displacement of the ventricular system to the left. The capacity of the left side of the cranial cavity is distinctly smaller than the right. Normal sulci markings are seen over the right cerebral hemisphere while none are visible over the diseased cortex (Fig. 7).

The etiology in this case is obviously a trauma occurring after birth, with immediate onset of convulsions and hemiplegia. The peculiar nature of the seizures, associated by hallucinations of taste which have persisted to date, are further evidence of the focal character of the lesion. In this patient, with a post-traumatic cerebral degeneration, the changes in the skull were similar to those seen in the cases previously described in which the intracranial lesion was the result of an infectious process.

CASE 4. Edward H., N.I. No. 9717, aged 15 years, admitted to the Institute August 28, 1931. Probable birth injury; convulsions at 7 months; right hemiplegia; mental deficiency. Skull on X-ray examination shows thickening greater on left; left overdevelopment of ethmoid and mastoid cells; dilated left lateral ventricle; shift of ventricles toward the left.

Complaint. Convulsions.

Present illness. The patient was a first child born at full term. He was a rather large infant at birth weighing 8½ pounds (3863 grams) and his mother was in labor 48 hours. The eventual delivery was instrumental, but the child reacted quite normally. At 7 months he began to have convulsions, generalized in character, which recurred at short intervals until the age of 10 years. He was free from seizures from 10 to 12½ years, then began to have both major and minor attacks. The former were initiated by flashes of light which were followed by spasms on the right side, urinary incontinence

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 10. Case 5. Anteroposterior roentgenogram showing the overdevelopment of the right frontal and ethmoid sinuses and aeration of the right petrous pyramid.

Fig. 11. Case 5. Anteroposterior roentgenogram (underexposed) shows marked thickening of right half of skull.

Fig. 12. Case 5. Anteroposterior encephalogram showing the enlargement of the right lateral ventricle and the shift to the right of the entire ventricular system. Note also the changes that are present in the skull and sinuses.

and drowsiness. The latter consisted of momentary flashes of light only. The patient has been somewhat backward at school which he quit at the age of 12, after reaching Grade 5A. He was especially deficient in arithmetic.

Physical examination. The patient is a rather tall, somewhat obese, dull boy. There is present a right spastic hemiplegia with underdevelopment and deformity of the paralyzed side, and a hypalgesia and hypæsthesia of the right side as well. Reflex changes are in conformity with the other findings. No hemianopsia exists.

Fig. 13. Case 5. Lateral encephalogram which shows the enlargement of the entire right lateral ventricle. The arrows point to the pneumatized superior orbital plate of the right side.

Fig. 14. Case 6. Anteroposterior encephalogram showing the dilatation of the right lateral ventricle and the shift of the ventricles to the right. Note the asymmetry of petrous pyramids and thickening of right half of skull.

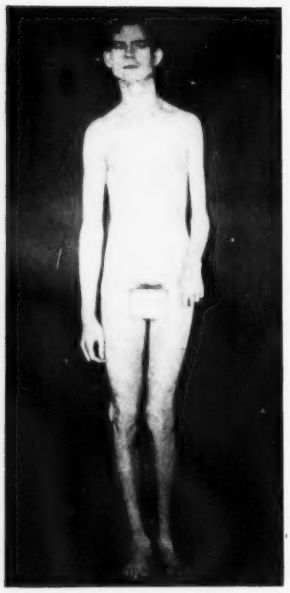


Fig. 15. Case 7. Photograph of Douglas G. showing the underdevelopment of the left side of the body and the hemiplegic attitude.

Laboratory findings. All clinical laboratory examinations on the blood, urine, and spinal fluid showed negative results.

Roentgen-ray findings. The tables of the skull show a thickening beyond normal for this age and this thickening is more apparent on the left side. The left ethmoid cells are overdeveloped and extend well backward into the orbital plate. The petrous portion of the left temporal bone is pneumatized (Fig. 8).

Encephalograms show a dilatation of the left lateral ventricle and a slight dilatation of the third ventricle, with a displacement of the ventricular system toward the left. The capacity of the left side of the cranial cavity is markedly less than that of the right side. Delicate, apparently normal, sulci are outlined by air on the right side, but on the side of the cerebral lesion no air is demonstrable over the cortex (Fig. 9).

This patient began to have convulsions with no other etiologic factor than a difficult birth. The fact that the seizures did not begin until 7 months of age is quite compatible with the belief that the birth injury produced the underlying cerebral defect. In spite of the difference in etiology, the changes seen on the encephalograms and on the plain films of the skull are very similar to those seen in the preceding cases.

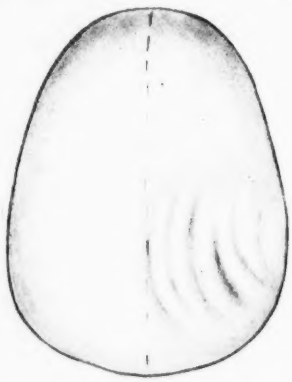


Fig. 16. Case 7. Sketch of the scalp, seen from above, illustrating the redundancy of the soft tissues over the flattened right side of the skull.

Case 5. Irene J., C.H. No. 22218, aged 15 years, admitted to the Institute March 7, 1932. Sudden onset at 6 years; convulsions; left hemiplegia; mental retardation. Thickening of right side of skull; overdevelopment of right ethmoid and mastoid cells; dilated right lateral ventricle and displacement of ventricles toward the right.

Complaint. Convulsions and left sided weakness.

Present illness. The child is the fifth in the family and was born at term after a short and normal labor. She was apparently quite well until the age of 6. At this age, one morning at 9:30, she had a sudden convulsive seizure causing her to fall to the floor. The left arm drew up in flexion and adduction; later all four extremities became involved. She was unconscious during the attack. The Board of Health considered it a case of "infantile paralysis." The child was hospitalized for a period of 6 months where she remained in bed for the greater part of this time because of the frequency of the seizures. She continued to have convulsions after discharge, although during 1929 and again in 1930 she had periods of almost a year each without convulsions.

Since November, 1931, the attacks have been almost a daily occurrence. She calls out in a stifled manner; the left forearm becomes slowly flexed at the elbow; all four extremities then become tense; she grows very pale; is incontinent of urine. She may remain sitting or standing; no clonic movements occur. The seizures usually last 5 minutes after which she may feel drowsy or sleep for a short time.

The girl is apparently mentally retarded; her memory is poor and her reactions rather infantile.

Physical examination. The patient is a well developed, pubescent girl with a spastic contracted

Fig. 17.

Fig. 18.

Fig. 19.

Fig. 17. Case 7. Anteroposterior encephalogram showing the marked enlargement of the right lateral ventricle and the displacement of the ventricles to the right. Note the enlarged sinuses on the right.

Fig. 18. Case 7. Postero-anterior encephalogram showing the asymmetry and thickening of the right side of the skull in addition to the changes which are described in Figure 17.

Fig. 19. Case 7. Lateral encephalogram showing the extensive enlargement of the right lateral ventricle. Note the flattening of the posterior portion of the parietal bone, the result of birth trauma.

left arm and a spastic left lower extremity. Reflexes are definitely increased on the left, but no abnormal reflexes are present. Sensation is normal. There is an incomplete left homonymous hemianopsia. There appears to be a left facial atrophy associated with a hypoplasia of the left extremities and left half of the body.

Laboratory findings. All clinical and serological examinations of blood, urine, and spinal fluid proved negative.

Roentgen-ray examination. The right side of the skull shows a thickness of the vault of 11 millimeters as compared to 4 millimeters on the left. The right orbital plate up to the base of the anterior clinoid process is widened by the extension of the ethmoidal cells between its tables. The petrous bones are hypertrophied by unequal pneumatization, the right being much larger than the left (Figs. 10 and 11).

Encephalograms show a dilatation of the right lateral ventricle with displacement of the entire ventricular system to the right. The capacity of the right side of the cranial cavity is markedly smaller than that of the left side. A few fine sulci markings are present on the left, but none are visible on the right side (Figs. 12 and 13).

This is another case with a history suggesting an infectious cerebral process at the onset of the illness. Obviously it was not acute anterior poliomyelitis as suggested at the time, although the infectious agent may have been similar to the one causing this disease. In any event, the result of this illness was an extensive right cerebral damage with consequent characteristic changes in the skull.

Case 6. Elizabeth R., N.I. No. 5062H, aged 15 years, admitted to the Institute July 30, 1930. Probable birth trauma. Left hemiplegia first noted a few months after birth; generalized convulsions since the age of 5; subnormal mental development. Hypertrophy of right side of skull and sinuses with dilatation of right lateral ventricle and decreased capacity of right side of skull.

Complaint. Generalized convulsive seizures, severe frontal headache, left sided weakness.

Present illness. The patient was the second child, born at full term by an apparently normal delivery. However, within a few months after birth, the mother noticed that her left hand was smaller than the right, and that she did not use it. When the patient began to walk, at 1 year, her mother noticed weakness, stiffness, and dragging of the left foot. Mental development was apparently normal.

At 5 years of age, she began to have generalized convulsions, initiated by a cry. These attacks occurred once or twice monthly and were followed by severe frontal headache, nausea, and sometimes vomiting. Between attacks, the child often complained of "heaviness" and dull pain in the left arm. In the past few years she has been somewhat slow in comprehension and lacking in alertness. She reached the fifth grade in school at the age of 13.

Physical examination. A pale undernourished girl with left sided spastic paralysis. There are occasional involuntary twitchings of the paralyzed extremities. These show hyperactive reflexes and a mild degree

Fig. 20. Case 8. Anteroposterior encephalogram showing the marked enlargement of the right lateral ventricle with a shift of the ventricular system to the right. This figure shows unusually well the hyperpneumatization of the right petrous pyramid. There is some overdevelopment of the right frontal and ethmoid sinuses and slight homolateral thickening of the skull.

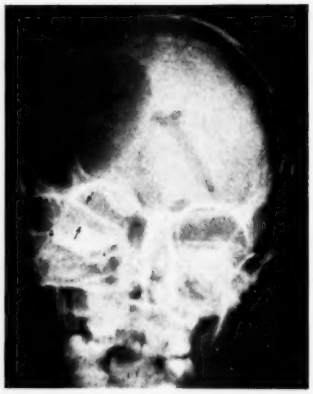


Fig. 21. Case 8. Postero-anterior encephalogram showing the marked enlargement of the posterior portion of the right lateral ventricle.

of hypalgesia. There is a questionable left positive Babinski sign.

Laboratory findings. The clinical laboratory examinations proved negative including spinal fluid examination. Basal metabolic rate was minus 16.

Roentgen-ray examination. There is definite thickening of the skull on the right side with a moderate degree of overdevelopment of the frontal sinus on the right as seen in the plain films. The petrous portion of the temporal lobe on the right side shows considerable pneumatization.

Encephalograms show a dilatation of the right ventricle. All the sulci are widened but this is more evident on the right as compared to the left side. There is a shift of the entire ventricular system toward the right. The capacity of the right side of the cranial cavity is distinctly smaller than the left (Fig. 14).

This child has had left sided paresis since early infancy. Whether the cerebral lesion developed at the time of birth or during intrauterine life cannot be determined. However, the picture, both from a clinical and roentgenological standpoint, closely resembles that seen in the other cases. Unlike so many of the other cases, however, sulci markings on the affected side are not only present, but appear to be coarser than in normal individuals. It is of interest that while the paralysis was evident shortly after birth, the convulsive seizures did not begin until she was 5 years of age.

CASE 7. Douglas G., N.I. No. 12436, aged 16 years, admitted to the Institute May 9, 1932. Birth trauma; left hemiplegia; slight mental retardation; onset of Jacksonian seizures, later becoming generalized at 15 years. Overdevelopment of the ethmoid sinus and mastoid, with slight thickening and marked flattening of the skull on the right side. Dilatation of right lateral ventricle and shift of ventricular system toward the right; reduced capacity of the right side of intracranial cavity. Surgical exploration disclosing extensive adhesions and degenerated sclerotic brain on right side.

Complaint. Convulsions, left sided paralysis, backwardness in school.

Present illness. The patient was the first child and was born after a 36 hour labor, by an instrumental delivery. Following birth he had a "bump" on the right side of the head which took 3 weeks to disappear. From the very beginning there was great difficulty in "making him nurse." On the third day he "turned yellow" and lost several pounds, and the mother was told he had had a hæmorrhage of the brain.

At 5 months of age, the mother first noted paralysis of the left hand and leg. He first walked at 20 months of age and began to speak articulated words at the end of the second year. The paralysis may have improved somewhat, but continued evident up to the present time, and the child's mental development was always somewhat below par.

In July, 1931, the patient had his first convulsion, since which time he has had an average of about one a month. The seizures were characterized by a turning of the head to the left, followed by unconsciousness, and falling backward and to the left. At first, after falling, the left side alone was seized

by a series of clonic spasms, but since December, 1931, the entire body participates in the convulsion. The day following the attack he was restless, complained of headache, and dragged the left foot more markedly than before.

Physical examination. The patient is a tall, thin boy, showing marked underdevelopment of the left side of the body (Fig. 15), especially noticeable in the left arm and leg. Corrugation of the scalp is noted over the right parietal region corresponding to the flattening of the skull on this side (Fig. 16). There are weakness and spasticity in the underdeveloped extremities with increase of deep reflexes and positive Babinski and Chaddock signs. There is a scoliosis with the convexity to the left in the mid-thoracic region. No sensory disturbances are demonstrable. A marked left homonymous hemianopsia is present. Mental tests prove him to have a low average mental capacity.

Laboratory examination. The laboratory tests on the blood, urine, and spinal fluid were negative.

Roentgen-ray examination. There is slight thickening and rather marked flattening of the right side of the skull. The ethmoid sinus on the right side is overdeveloped and extends posteriorly over the orbit. The right mastoid cells have pneumatized the petrous portion of the temporal bone on that side.

Encephalograms show an enormous dilatation of the right lateral ventricle with a marked displacement of the entire ventricular system toward the right. All of this results in an extensive reduction in space occupied by the right cerebral hemisphere. Sulci markings which appear normal on the left, are not demonstrable over the defective hemisphere (Figs. 17, 18, 19).

Treatment. While nothing could be promised by operation, the patient's family was anxious to have everything possible done for him, and a right cerebral exploration was carried out.

Operation. June 10, 1932, a right temporoparietal osteoplastic flap was made. The under surface of the dura was adherent to the piarachnoid. After separating innumerable fine adhesions, a thin shell of degenerated, sclerotic brain fell away from the dura. So far as could be seen, no healthy brain tissue was present anywhere in this entire half of the cerebrum. The lesion was so extensive that removal of the scar tissue was unthinkable since this would have been tantamount to a removal of the entire hemisphere. It was hoped, however, that a separation of all the fine, avascular adhesions might reduce the tendency to convulsive seizures. A specimen of the sclerotic cortex was taken.

Pathological report. The tissue consists almost entirely of fibrillary astrocytes and glial fibrils. Aside from a rare, very markedly degenerated, almost unrecognizable ganglion cell, the preparation might easily be mistaken for one originating from a fibrillary astrocytoma.

Postoperative course. The boy made an uneventful recovery and was discharged 15 days after the operation. During his stay in the hospital he did not have any convulsive seizure. He was seen 6 months after discharge at which time he and his mother reported that the convulsions had returned, but that they were less frequent and less severe than before the operation.

This patient's malady obviously followed trauma during birth. He showed even more strikingly than the previous patient, the long interval between the time of the injury and the onset of convulsive seizures. The roentgenograms are again characteristic, although there is much less thickening of the skull of the affected side which has apparently been compensated for by the unusual degree of flattening of the skull on the side of the cerebral lesion.

The operation disclosed an atrophy and sclerosis which involved almost the entire right cerebral hemisphere, and histological examination revealed practically no parenchymatous brain tissue. It should also be noted that the sclerotic hemisphere was everywhere adherent to the dura, which probably accounted for the absence of sulci markings on this side of the brain in the encephalogram.

CASE 8. Lillian G., N.I. No. 12840, aged 9 years, admitted to the Institute June 15, 1932. Acute onset. Unconsciousness, fever, and left hemiplegia at 15 months; left Jacksonian seizures beginning at 6 years; feeble mindedness. Hypertrophy of right ethmoid and mastoid cells; dilatation of right lateral ventricle with a shift of ventricular system to the right.

Complaint. Convulsions, and paralysis of the left arm.

Present illness. The patient is the third child, born at term by a normal delivery. She was entirely well until 1 year of age when she had apparently uncomplicated measles. At 15 months she became suddenly ill, vomited, and became unconscious. This lasted for a week and was accompanied by high fever. On regaining consciousness, it was noted that she had a left hemiplegia. The hemiplegia gradually disappeared during the following 2 years except for a residual in the left upper extremity. At the age of 3, she had mastoiditis on the left, complicated by erysipelas. This was successfully operated upon but a sinus has remained with occasional discharge of pus.

She had mumps at 6 years and this was followed by the onset of convulsive seizures. The attacks occurred during the early hours of the morning and consisted of a premonitory cry, followed by a jerking of the left arm and unconsciousness. There was frothing at the mouth and often incontinence but no generalized convulsive movements. At first the attacks came once a month, but recently they have

occurred almost nightly. During the week previous to admission she complained of pain in the left arm.

Physical examination. The child is well nourished and co-operative. She has a left spastic hemiparesis and the paretic extremities are shorter and smaller than the right. The deep reflexes on the left are hyperactive, left abdominal reflexes are absent, and Babinski's sign on the left is positive. Sensation and visual fields are apparently normal. On the Terman test the child shows a mental age of 5 years and 4 months, with an intelligence quotient of 55.

Laboratory findings. Clinical laboratory findings on the blood, urine, and spinal fluid are negative.

Roentgen-ray examination. There is a thickening of the right orbital plate and an elevation of the right petrous ridge due to pneumatization. However, there is no thicken ng of the skull.

Encephalograms show a markedly dilated right ventricle with a displacement of the ventricular system toward the right. The capacity of the right side of the cranial cavity is distinctly smaller than that of the left. Sulci markings are not visible over either hemisphere (Figs. 20 and 21).

This is another case with an infectious etiology. The patient also showed a long latent interval between the acute stage of the disease and the appearance of seizures. In this case the onset of the attacks seems to have coincided with an attack of mumps. The roentgenograms are again quite typical except for the absence of thickening of the cranial vault.

CASE 9. Richard P., N.I. No. 12907, aged 8 years, admitted to the Institute June 21, 1932. Birth trauma; delayed walking and talking; clonic seizures since age of 5. At 6, onset of focal seizures on left side; left sided weakness and subnormal mentality. Moderate overdevelopment of the sinuses and mastoid on right; no thickening of skull; capacity of right half of cranial cavity less than left; right ventricle larger than left and ventricles shifted slightly to right.

Complaint. Convulsions and left sided weakness.

Present illness. The birth was precipitate and the child was born with the umbilical cord around his neck. He was cyanotic for several hours after birth and took the breast with difficulty. He did not sit up until 1 year of age, did not begin walking until 2½ years, and talking at 3 years. At 4, he had measles and diphtheria. About a year later, he had a seizure consisting of shaking of the whole body without loss of consciousness. A similar attack occurred about 3 months afterward. At 6 he began to have attacks of a different character which have continued to date. These are preceded by irritability and headache. The seizure consists of pain in the left arm and left side of the face, followed by twitching movements in these parts which later involve the left leg. This lasts for about 5 minutes after which he usually becomes unconscious and the convulsions continue, clonic in character, and confined to the left side, for a period of 2 or 3 hours. These seizures have occurred about once every 2 months during the past 2 years.

He has never been to school and has never learned to write. The family history is entirely negative.

Physical examination. The patient is a well nourished boy, who is obviously somewhat mentally defective. He walks with his knees slightly flexed and his mouth open, and there are no associated movements of the upper extremities. There is obvious weakness and awkwardness in the use of the left upper extremity as well as a positive Babinski sign on the left.

Laboratory findings. The clinical laboratory examinations were negative.

Roentgen-ray examination. Plain films of the skull show slight thickening of the right orbital plate. The right ethmoid and frontal sinuses extend posteriorly and partially pneumatize the orbital plate. The mastoid on the right is overdeveloped, and air cells extend well into the petrous portion of the temporal bone.

Encephalograms show the right ventricle to be considerably dilated and the entire ventricular system is displaced somewhat toward the right side. The capacity of the right side of the intracranial cavity is smaller than the left. Coarse sulci markings are present over the medial and superior aspects of the right cerebral hemisphere.

In this case, the child suffered from asphyxia at birth rather than violence to the head. The retarded development, however, would indicate some cerebral disturbance since that time. The failure, by the family, to note a left hemiparesis even at the time of admission to the hospital makes it impossible to say how early this condition appeared. It may very well have been present at birth. From the previous cases, it is obvious that the delayed appearance of seizures until the age of 5 is compatible with an acute episode at birth.

The changes seen in the roentgenograms of this, as well as the preceding case, are typical although less marked than the others. This is probably due to the youth of these patients at the time of examination (9 and 8 years respectively) for it seems likely that the thickening of the skull and the overdevelopment of the sinuses take many years to reach their maximum degree.

ETIOLOGY

The clinical picture of infantile hemiplegia has been so frequently and so adequately described in monographs, papers, and stan-

ard textbooks of neurology that very little can be added here. For the most part, our cases correspond to the classical description presented by Freud, Oppenheim, Déjerine, Sachs, Peritz, and others. Sachs distinguishes between prenatal, birth, and postnatal paralyses. Among our 9 cases, there was only one possible example (Case 6) of the prenatal type. Two cases occurring during birth were probably due to instrumental, or otherwise difficult birth. One patient was evidently the victim of partial asphyxiation due to a tight umbilical cord around his neck. Of the 5 other patients, 4 showed a sudden onset postnatally, with fever, convulsions, and hemiplegia, and in the fifth the symptoms began after a severe fall at the age of 1 year. From this, it is evident that uniformity of etiology is out of the question. Moreover, the same may be said for the pathological process. Most of the lesions described by others at postmortem and noted by us during operation are end processes of some previous disturbance. They are usually focal cerebral defects of varying extent: softening, cyst-formation, scar formation with contraction, induration, or defect of the cerebrum (porencephaly). The latter is usually located in the distribution of the middle cerebral artery and is probably secondary to disease of this vessel.

Clinically, too, the picture is a varied one. The hemiplegia may occur immediately or be noted some time after the trauma or acute infectious episode. The convulsions may likewise be present at once, or start many months, sometimes many years later (see Case 7). There is often a noteworthy interval of months, sometimes years, between convulsions. Finally the seizures may change completely in character (see Cases 2, 4, and 9), or a second type of seizure may appear which runs in a cycle independent of the original type (Case 3). At the onset of the disease the convulsions may be either generalized or initiated by a motor Jacksonian attack. In Case 2, for example, the illness started at 1 year with seizures beginning with right sided twitching going over to generalized clonic convulsions. These attacks recurred frequently until 3. There were no attacks between 3 and 16 years of age. Seizures then made their appearance which consisted of gripping pain in the right temple in addition to numbness in the right arm, leg, and face, and difficulty in speech. The later seizures, however, often take on the character of a sensory discharge.

The one thing that all of these patients show in common is the early age of onset of the disease. All our patients date their illness back either to birth or to within the first 15 months of life, with the exception of Case 5 in which the symptoms began at 6 years. This fact appears significant in accounting for the profound and uniform changes in the skull.

It is common knowledge that the infant's skull is relatively soft and malleable and that external factors such, for example, as strapping the child on a board, as commonly practiced among primitive races, results in corresponding flat areas of the skull. On the other hand, factors affecting the inner table, such as the expansion of the normally growing brain in cases of congenital synostosis, or the pathological enlargement of the brain in hydrocephalus, again results in deformity of the skull. The immature skull, therefore, obviously responds to positive pressure whether from within or without.

Given a normal child's skull, however, that is freed from the pressure within, as a result of localized shrinkage of the brain from trauma or infection, something akin to a negative pressure must take place. This new stimulus is only partially satisfied by the local collection of cerebrospinal fluid, i.e., the dilatation of the homolateral ventricle with the displacement of the brain toward the affected side. The equalization of pressure is completed by a reduction in the capacity of the cranial cavity in the region of the brain lesion. This is brought about by a thickening of the skull and an expansion of the air sinuses.

If the bones are soft enough, an actual flattening or even depression of the vault on the side of the lesion may occur. If, on the other hand, the vault is rigid enough to withstand the unequal pressure from the two sides, the osteoblasts of the inner table are unequally stimulated to activity and a thickening of the bones of the skull over the defect results, or the normal absorption of the inner table fails to take place and the thickening

follows in consequence thereof. The changes in the bone occur very slowly as evidenced by the very little thickening which was present in our two youngest patients (Cases 8 and 9) who were only 9 and 8 years old respectively, although they showed the other characteristic changes. This suggests that the overdevelopment of the sinuses precedes, or at least takes place at a more rapid rate than, the thickening of the skull. Where the parietes of the skull are lined by the walls of the air chambers such as the ethmoidal, frontal, and mastoid cells, the process of space elimination occurs by an expansion of these air spaces and a pneumatization of the bone beyond the usual limits of the air cells. The only air sinuses participating in this change are in the order of their importance the ethmoids, mastoids, and frontals. Meanwhile, the falx and the normal half of the brain respond to the same stimuli by a displacement of their unattached portions toward the defect. The pineal body, which was visible in two cases, was found to be displaced to the side of the lesion in one of them (Case 7). The pathological cerebral hemisphere itself makes up for the loss of substance by a dilatation of its ventricle—a sort of unilateral hydrocephalus *ex vacuo*.

A situation much better known and in many ways analogous to the one just described for the cranial cavity is seen in the chest following chronic empyema. When closure of the cavity occurs before the lung is expanded, such movable portions of the chest which bound the affected side are moved inward to fill the space usually occupied by the normal expanded lung. The intercostal spaces decrease by the approximation of the ribs to each other. The diaphragm on this side becomes elevated and the heart and mediastinal contents become displaced toward the lesion, all of which produces a diminished capacity of the half of the chest which houses the collapsed lung, and results in an equalization of pressure in response to altered conditions.

As the patient with infantile hemiplegia grows older, the healthy side of the brain continues to develop while the affected side remains arrested. Whether due to some unexplained striving for symmetry or a stimulus to outward expansion transmitted to it from the other side, the skull on the affected side continues to grow externally although lagging behind the normal half. This necessitates correspondingly slow but continued progression of the corrective factors on the inner aspect of the skull described above until the normal growth period is at an end.

SUMMARY AND CONCLUSIONS

Nine patients with a clinical picture of infantile hemiplegia are reported, with especial emphasis on the roentgenological changes occurring in the skull. The roentgenograms reveal a thickening of the cranial vault on the same side as the cerebral lesion and also an overdevelopment of the frontal and ethmoid sinuses and of the air cells of the petrous pyramid of the temporal bone. On the encephalograms there is an enlargement of the lateral ventricle on the side of the cranial lesion and sometimes of the third ventricle, and both these structures are displaced toward this side. The displacement must not be confused with that produced by tumor, and the differentiation, roentgenologically, can be made by noting the changes in the cranial vault and sinuses described, and the absence of signs of increased intracranial pressure. Coarse sulci or abnormal collections of air in the subarachnoid space may be present on the pathological side. On the other hand, owing to adhesions no sulci markings may be seen.

The association of these encephalographic findings with the thickening of the skull and the homolateral dilatation of the air cells of the sinuses is so constant that, when definite, the skull changes alone without the aid of encephalography permit one to make a diagnosis of localized cerebral hypoplasia.

BIBLIOGRAPHY

1. Cotard, Jules. Étude sur l'atrophie cérébrale. Thèse de Paris, A. Parent, 1868.
2. Déjerine, J. Sémiologie des affections due système nerveux. P. 248, Paris: Masson, 1914.
3. Freud, Sigmund. Die infantile Cerebrallaehmungen. Vienna: Holder, 1897.
4. Oppenheim, H. Lehrbuch der Nervenkrankheiten. 6th ed., ii, 1105. Berlin: Karger, 1913.
5. Peritz, Georg. Die Nervenkrankheiten des Kindesalters. 2d ed., p. 163. Leipzig: Fischer, 1932.
6. Peterson, F., and Fisher, E. D. Cranial measurements in twenty cases of infantile hemiplegia. New York M. J., 1889, xlix, 365–373.

THE NECESSITY FOR CONSTANT SUCTION TO INLYING NASAL TUBES FOR EFFECTUAL DECOMPRESSION OR DRAINAGE OF UPPER GASTRO-INTESTINAL TRACT

With Comments Upon Drainage of Other Body Cavities

JOHN R. PAINE, M.D., and OWEN H. WANGENSTEEN, M.D.,[1] F.A.C.S., Minneapolis, Minnesota

THE duodenal tube has become established as an agent of real value in the relief of distention of the upper reaches of the gastro-intestinal tract. It is more than 20 years since its use was first advocated by Westermann and Kappis in the treatment of the distention of peritonitis. Until recent years, however, the employment of the duodenal tube for this purpose enjoyed but sporadic and desultory usage. The introduction of the smooth catheter tipped (nasal) duodenal tube by Levin in 1921 and the publications of McIver and his associates, establishing swallowed air as the chief offender in the causation of postoperative gaseous distention, lent considerable impetus to wider and more frequent employment of the duodenal tube in the treatment of postoperative nausea, vomiting, and distention.

In 1931, it was found at the Minnesota General Hospital that instances of acute mechanical obstruction of the small intestine of adhesive origin could be satisfactorily decompressed by nasal catheter suction siphonage without operation (6). Since then, we have studied and tried to evaluate the mechanical and physiological factors which determine the possibilities, limitations, and efficacy of decompression of the distended alimentary canal.

The element of suction we believed and found to be a significant item in accomplishing adequate decompression of the distended intestine. It has so frequently been suggested that an inlying catheter employed as a siphon without the suction principle would achieve the same effect, that it would appear to be worth while to examine the results of these two methods of drainage. Robertson Ward of San Francisco was apparently the first to employ in connection with the inlying duodenal catheter the principle of continuous suction in treating postoperative distention.

THE MARIOTTE BOTTLE

By attaching a Mariotte bottle[2] to a duodenal tube employed as a siphon the gas as well as the fluid aspirated can be collected and measured without influencing in any manner the action of the siphon. This bottle in brief consists of two glass beakers, one of the beakers being inverted and fitting inside the other. At the base of the inverted beaker are openings through which fluid may pass. The top of the inverted beaker has two openings. One of these is used as an outlet for air when the apparatus is being set up ready for use. A glass tube passes through the other opening. The upper end of this glass tube is attached to the duodenal tube and the lower end projects down to a level with the overflow spout on the outer beaker.

By inspecting the accompanying diagram (Fig. 1), it may be seen that the end of the glass tube projecting down into the inner beaker will always be at exactly the same height as the surface of the water in the outer beaker. This fact insures the maintenance of atmospheric pressure at the end of the glass tube and simulates exactly the conditions present when a duodenal tube is used as a siphon. When the siphon with Mariotte bottle attached is to be started the inner, inverted beaker is filled with water and the outer beaker is filled up to the overflow spout. As fluid is removed from the stomach the fluid level in the outer beaker is raised and an equal quantity drains into the lower bottle. As gas is removed it rises in the inverted beaker and collects at the top where its volume may be read directly on a calibrated scale. The gas displaces an equal volume of fluid, however, which drains into the lower bottle. By subtracting the volume of gas from the volume of fluid in the lower bottle the quantity

[2]Edme Mariotte, French physician and physicist, born 1620, died 1684.

[1]From the Department of Surgery of the University of Minnesota

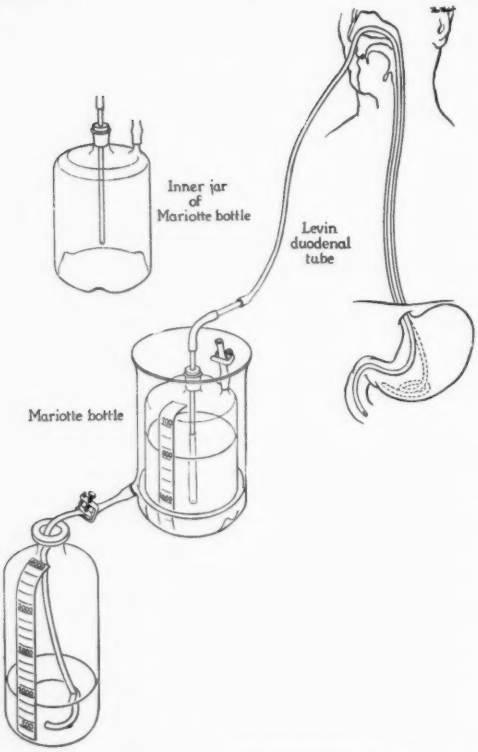


Fig. 1. Mariotte bottle. The attachment of this bottle to a duodenal tube acting as a siphon does not interfere in any way with its action, but allows the gas as well as the fluid to be collected and measured. The overflow spout on the outer beaker is at the same height as the lower end of the glass tube, thus maintaining this point at atmospheric pressure. To set up the apparatus the tube from the overflow spout is clamped and the opening at the top of the inner beaker opened. The outer beaker is filled with water. The opening at the top of the inner beaker is closed and the clamp on the tube from the overflow spout is opened.

of fluid removed from the patient will be found.

Slightly different conditions exist when siphonage tubes draining both fluid and gas are allowed to operate with the ends submerged in water, i.e., water sealed drainage. In this latter type of drainage, provided only fluid is being aspirated, it makes no difference as far as concerns the effectiveness of the system whether the end of the drainage tube is submerged in fluid or not; but if both fluid and gas are expected to come through the tube then the effectiveness of the system is diminished as far as the liberation of gas is concerned by as much as the tube is submerged under fluid. A concrete example will serve to illustrate the above point. Given a duodenal tube used as a siphon with water sealed drainage. The patient's bed is approximately 75 centimeters above the floor and the end of the tube is submerged 6 centimeters below the surface of the drainage fluid which is contained in a bottle placed on the floor. As long as fluid alone fills the tube no check to its operation exists, but if gas enters the system none can be expected to leave the submerged end of the tube until a pressure equal to the weight of the column of fluid above the end of the tube (6 grams) is overcome. The purpose of water sealed drainage is to prevent the retrograde passage of air into the system and hence spoiling the siphonage action. This retrograde passage of air will not occur if the caliber of the tube is small enough to allow the surface tension of the fluid in the tube to keep the column intact. The Mariotte bottle prevents this retrograde passage of air no matter what the caliber of the tube is and at the same time eliminates the necessity of gas being forced out under pressure which is inherent in all water sealed systems.

DETAILS OF STUDY

For this report 19 cases have been studied in detail. These cases comprise 17 cholecystectomies, 1 interval appendectomy, and 1 inguinal hernia. All cases had spinal anæsthesia (novocain crystals). This was frequently supplemented with nitrous oxide gas or ethylene. Four of these cases including 2 cholecystectomies and both the appendectomy and herniotomy were treated by duodenal tube siphonage without the Mariotte bottle attached to serve as a control for the remaining 15 cases, in which the Mariotte bottle was attached. In all instances a Levin duodenal tube No. 16 F. was inserted through the nose into the stomach and kept in place for between 24 and 48 hours. All patients except the controls were permitted to drink two thousand cubic centimeters of clear fluids each day although no attempt was made to see that they drank that amount. The control cases were allowed as much clear fluid as they wished.

A summary of the control cases appears in Table I. While the number is too small to warrant any definite conclusions it would seem that they did very well clinically. However, there is no definite correlation between the oral intake of fluid and the fluid drainage. In addition both of the cholecystectomies were nauseated during the period of siphonage and one vomited twice. Distention was present in both of these cases.

Five patients were treated after operation by duodenal siphonage with the Mariotte bottle attached. The amounts of gas and fluid removed from the stomach were carefully measured. Their clinical course with regard to nausea, vomiting, and distention was closely followed. In 4 patients cholecystectomy was performed for chronic cholecystitis and cholelithiasis and in the other, exploration of the common duct was done at which time a stricture was repaired and a T tube inserted into the choledochus. In these cases again there appeared to be no close correlation between the intake of oral fluids and the amount reaspirated (see Table I).

Table II indicates the quantities of gas and fluid aspirated together with the oral and para-oral fluids which were given. It will be noticed also that all of these patients were nauseated, vomited, and had more or less distention. This is in marked contrast to the results obtained when patients with cholecystectomy are treated after operation with nasal catheter suction (5). The amounts of gas and fluid aspirated by suction are much larger. About two thousand cubic centimeters of gas a day is removed from the stomach and upper intestinal tract. The amount of fluid aspirated with suction depends in part on the amount of oral fluid given as well as upon the degree of inertness of the bowel present.

Two patients with cholecystectomies were treated after operation with siphonage for 2 days. The amounts of fluid and gas removed from the stomach were measured. At the end of this period suction was applied to the duodenal tube for 10 minutes. The additional amounts of gas and fluid removed were measured (see Table III). The gas and fluid obtained by suction in these 2 cases is direct evidence of the inefficiency of siphonage as compared with suction in keeping the upper gastro-intestinal tract empty. While the amounts of gas and fluid obtained by suction in these 2 cases may appear small it should be borne in mind that such amounts represent the residue left after 48 hours of siphonage and do not include quantities of gas and fluid which may have passed into the intestine during that time and caused more or less distention and distress.

Since the purpose of our study was to test the effectiveness of the two systems of drainage more valuable information would probably be obtained if suction were instituted for a short time at different intervals during the 48 hours or if siphonage and suction were alternated at equal intervals (see Tables II, III, and IV).

Pursuing the investigation further 3 patients were treated following cholecystectomy by duodenal tube siphonage alternated with

TABLE I.—CONTROL CASES

Patients treated after operation by siphonage through a duodenal tube (Mariotte bottle not attached . The quantities of fluid obtained from the stomach by a Levin duodenal tube used as a siphon together with an estimation of the clinical condition of the patient as far as nausea, vomiting, and distention are concerned is shown.

	Patient A. P. Herniotomy*		Patient E. L. Appendectomy*			Patient E. T. Cholecystectomy			Patient B. S. Cholecystectomy		
	1st day	2nd day	1st day	2nd day	3rd day	1st day	2nd day	3rd day	1st day	2nd day	3rd day
Fluid drainage (c.cm.)	1600	1400	600	200	100	3800	2000	600	400	250	....
Oral fluid (c.cm.)	1400	2850	600	2200	2550	2600	2250	4200	100	100	....
Subcutaneous fluid (c.cm.)	....	800	2000	2000	....	....	2000	....	....	2000	....
Intravenous fluid (c.cm.)	....	....	....	....	....	....	....	....	2000	....	....
Proctocly. (c.cm.)	....	....	....	....	....	1400	200	400	600	....	....
Urine (c.cm.)	450	1000	600	800	1200	475	1200	1400	850	900	750
Nausea	o	o	o	o	o	xxx	o	x	o	x	o
Vomiting	o	o	o	o	o	xx	o	o	o	x	o
Distention...	o	o	o	o	o	xx	xx	xx	x	x	x

*The absence of distention, nausea, and vomiting following appendectomy and herniotomy is not unusual, and has been commented upon elsewhere (5).

TABLE II.—SIPHONAGE THROUGH DUODENAL TUBE

Patients treated after cholecystectomy by siphonage through a duodenal tube (Mariotte bottle attached). The quantities of gas and fluid aspirated from the stomach by a Levin duodenal tube acting as a siphon together with an estimate of the clinical results obtained as far as comfort of the patient was concerned are shown.

	Patient J. M.		Patient F. F.		Patient M. M.			Patient A. M.			Patient A. B.		
	1st day	2nd day	1st day	2nd day	1st day	2nd day	3rd day	1st day	2nd day	3rd day	1st day	2nd day	3rd day
Fluid aspirated (c.cm.)	250	250	650	650	800	800	800	1000	1000	1000	200	200	200
Gas aspirated (c.cm.)	300	300	1700	1700	400	400	400	900	900	900	1000	1000	1000
Oral fluids (c.cm.)	....	1500	800	400	1000	850	1750	100	300	600	1000	1000	2000
Para-oral fluids (c.cm.)	2000	....	2000	2000	500	1500	600	1500	1500	1100	1000	2500	150
Urine (c.cm.)	225	125	600	500	1130	475	800	500	700	300	975	1150	1300
Nausea	xx	x	x	–	–	xxx	x	–	xx	x	–	x	–
Vomiting	xx	x	x	–	–	xxx	–	–	x	xx	–	x	–
Distention	–	xx	x	–	x	xx	xxx	x	xx	xx	x	x	x
Duration of siphonage	23 hr.		27 hr.		41 hr. 30 min.			47 hr. 20 min.			41 hr. 50 min.		

suction at different time intervals. Three hours of siphonage were alternated with 3 hours of suction in the first case. In the 2 other cases the periods were 6 and 9 hours, respectively. The quantities of gas and fluid obtained during these periods are shown in Table IV. On a fourth patient an attempt was made to alternate suction and siphonage at 9 hour intervals but this patient experienced so much nausea and distress during the periods of siphonage that she refused to have the suction cut off. The results in these 3 cases show that when suction and siphonage are alternated every few hours practically no fluid or gas is recovered during the periods of siphonage. This can probably be explained on purely mechanical principles and will be discussed later.

TABLE III.—SIPHONAGE WITH SUCTION AT END OF PERIOD

Patients treated after cholecystectomy by siphonage through a duodenal tube (Mariotte bottle attached) with suction being applied at the end of the period. The quantities of gas and fluid obtained from the stomach during 48 hours of siphonage with a Levin duodenal tube and the additional quantities of fluid and gas obtained when suction was applied to the tube for *10 minutes* at the end of the siphonage period are shown.

	Patient E. A.		Patient I. S.	
	1st day	2nd day	1st day	2nd day
Oral fluids (c.cm.)	.....	800	1850	2600
Para-oral fluids (c.cm.)	400	1000	1150	....
Urine (c.cm.)	200	800	550	575
Siphonage				
Gas (c.cm.)	400	400	1000	1000
Fluid (c.cm.)	400	400	1400	1400
Suction				
Gas (c.cm.)	100	100	300	300
Fluid (c.cm.)	150	150	350	350

Four patients were treated with siphonage following cholecystectomy. Suction was applied to the duodenal tube at intervals, the length of time usually being 10 minutes. It was applied at least once every 24 hours and more often when the patients complained because of the occurrence of nausea, vomiting, abdominal distress, or distention. The results obtained in these patients appear in Table V. If one keeps in mind the relative lengths of time the two systems were in use it is readily seen that duodenal tube siphonage is a much less effectual method of draining the upper gastro-intestinal tract than is duodenal tube suction.

RÉSUMÉ OF OBSERVATIONS

After examining the results one can not escape the impression that siphonage by means of a duodenal tube is an inefficient means of removing gas and fluid from the stomach and upper reaches of the intestine.

TABLE IV.—ALTERNATE SIPHONAGE AND SUCTION

Patients treated after cholecystectomy with alternate siphonage and suction through a duodenal tube (Mariotte bottle attached to siphon). The quantities of gas and fluid obtained by an inlying Levin duodenal tube in the stomach when siphonage and suction are alternated are shown.

Patient A. B.					Patient H. F.					Patient A. K.				
	Siphonage		Suction			Siphonage		Suction			Siphonage		Suction	
Time hrs.	Gas in c.cm.	Fluid c.cm.	Gas in c.cm.	Fluid c.cm.	Time hrs.	Gas in c.cm.	Fluid c.cm.	Gas in c.cm.	Fluid c.cm.	Time hrs.	Gas in c.cm.	Fluid c.cm.	Gas in c.cm.	Fluid c.cm.
3	0	0												
3			400	0	6			275	325	9	0	400		
3	0	0												
3			0	0	6	25	0			9			1600	100
3	25	40												
3			325	450	6			125	250	9	600	0		
3	0	0												
3			275	350	6	30	140			9			1500	500
3	0	0												
3			300	500	6			500	725	9	0	0		
3	0	0												
3			100	0	6	0	0							
3	0	0												
3			375	425	6			750	350	9			400	0
Total oral fluids				2950 c.cm.	Total oral fluids				900 c.cm.	Total oral fluids				3300 c.cm.
Total para-oral fluids				2600 c.cm.	Total para-oral fluids				4900 c.cm.	Total para-oral fluids				4900 c.cm.
Total urine				1450 c.cm.	Total urine				1175 c.cm.	Total urine				1975 c.cm.
Total time				42 hrs.	Total time				42 hrs.	Total time				54 hrs.

Almost invariably when suction was applied to a duodenal tube which had been serving as a siphon for some hours, relatively large additional quantities of both fluid and gas were obtained. These were present in the vicinity of the tube and yet were not removed by the siphonage action. It must not be concluded from this, however, that siphonage or water sealed drainage is equally ineffective in draining other cavities or organs. Inlying catheters used as siphons, whether sealed with water or not, drain the bladder very efficiently. Observations extending over several days on 6 patients with inlying catheters for bladder drainage showed that if the catheters were properly adjusted they kept the bladders entirely empty. At least attempts to aspirate urine with a syringe at various times during the day always failed. While the muscular contraction and tone of the bladder might serve to keep the bladder empty in the usual case, in atonic or paralyzed bladders the results were the same, and in such cases the absence of urinary stasis must primarily be due to the action of the siphon.

It was possible to make some observations on the effectiveness of water sealed drainage in two empyema cavities. One of these cavities had a capacity of about 350 cubic centimeters at the time these observations were made. The drainage tube fit snugly in the chest so that there was no leak and under this regimen about 100 cubic centimeters of thin pus was being recovered daily. Over a period of about 10 days, suction was applied to the drainage tube twice daily for a few moments at a time, but no additional pus was ever obtained. The other cavity which was of about 260 cubic centimeters' capacity was in an 18 year old boy who had had a drainage tube inserted before entering the hospital. This tube was cut off flush with the chest wall so that water sealed drainage could not be conveniently instituted. Another tube was inserted and water sealed drainage was established. About 150 cubic centimeters of pus was obtained daily by this

TABLE V.—SIPHONAGE WITH SUCTION AT INTERVALS THROUGH DAY

Patients treated after cholecystectomy with siphonage; suction being applied for short intervals during the day (Mariotte bottle attached to siphon). The quantities of gas and fluid aspirated from the stomach by a Levin duodenal tube used as a siphon are shown as well as the additional amounts obtained from the same patient when siphonage was interrupted for short intervals by the application of mild suction to the tube.

Patient W. C.

Time	Siphonage		Suction	
	Gas in c.cm.	Fluid c.cm.	Gas in c.cm.	Fluid c.cm.
8 hrs. 30 min.	0	0		
10 min.			400	300
4 hrs. 35 min.	0	200		
10 min.			300	900
13 hrs. 5 min.	1100	225		
9 hrs.			1900	300

Patient N. M.

Time	Siphonage		Suction	
	Gas in c.cm.	Fluid c.cm.	Gas in c.cm.	Fluid c.cm.
4 hrs. 30 min.			750	50
8 hrs. 30 min.	25	175		
10 min.			50	250
4 hrs. 55 min.	0	0		
10 min.			500	200
1 hr. 50 min.	0	0		
10 min.			0	0
3 hrs. 55 min.	0	0		
10 min.			0	600
2 hrs. 35 min.	75	325		
10 min.			800	600
5 hrs. 50 min.	0	0		
10 min.			400	500
2 hrs. 15 min.	0	0		
10 min.			200	400
2 hrs. 25 min.	0	0		
10 min.			200	200

TABLE V.—SIPHONAGE WITH SUCTION AT INTERVALS THROUGH DAY—Continued

Patient C. B.

Time	Siphonage		Suction	
	Gas in c.cm.	Fluid c.cm.	Gas in c.cm.	Fluid c.cm.
7 hrs.	400	0		
12 hrs. 30 min.			75	125
4 hrs. 30 min.	0	0		
10 min.			150	50
21 hrs. 50 min.	1100	550		
10 min.			300	450

Patient B. S.

Time	Siphonage		Suction	
	Gas in c.cm.	Fluid c.cm.	Gas in c.cm.	Fluid c.cm.
17 hrs. 20 min.	225	600		
3 hrs. 30 min.			200	400
19 hrs. 30 min.	400	1300		
10 min.			100	0
23 hrs. 55 min.	400	475		
10 min.			225	100

method. Suction applied several times a day yielded no additional pus for the first 2 days. On the third day the amount of drainage obtained by the water sealed system decreased and large bubbles of air could be seen in the drainage system. The application of suction at irregular intervals yielded from 20 to 100 cubic centimeters of pus at each aspiration. Since this patient did not have a bronchial fistula, these bubbles of gas must have come from leaks around the drainage tube. The leakage of air had decreased the efficiency of the drainage system in a marked degree.

The explanation of the ineffectiveness of siphonage in the gastro-intestinal canal and its adequacy in the drainage of empyema, of the bladder and other body cavities, appears to rest solely on mechanical and physical principles. The gastro-intestinal tract, especially the stomach, is unique among the cavi-

TABLE V.—Continued

SUMMARY

	Patient W. C.		Patient C. B.	
	Siphonage	Suction	Siphonage	Suction
Total time	26 hrs. 10 min.	9 hrs. 20 min.	38 hrs. 20 min.	12 hrs. 50 min.
Total gas aspirated (c.cm.)	1100	2600	1500	525
Total fluid aspirated (c.cm.)	425	1500	550	625
Total oral fluids (c.cm.)	1950		3100	
Total para-oral fluids (c.cm.)	5500		3650	
Total urine (c.cm.)	950		2225	
	Patient B. S.		Patient N. M.	
	Siphonage	Suction	Siphonage	Suction
Total time	60 hrs. 45 min.	3 hrs. 50 min.	32 hrs. 15 min.	5 hrs. 50 min.
Total gas aspirated (c.cm.)	1025	525	100	2900
Total fluid aspirated (c.cm.)	2375	500	500	2800
Total oral fluids (c.cm.)	3100		2800	
Total para-oral fluids (c.cm.)	5000		4000	
Total urine (c.cm.)	900		1150	

ties of the body in that both gas and fluid are present in relatively large quantities at the same time. The duodenal tube will serve as an excellent vent for gas as long as fluid does not block it, or it will serve as an excellent siphon for fluid as long as gas does not enter the tube and break the siphonage action. Once the continuous stream of fluid in the siphon tube is replaced by sufficient air, siphonage action ceases and can not re-establish itself until further fluid has accumulated within the stomach and an internal pressure has been built up high enough to force the gas out of the tube and re-establish a continuous column of fluid. Of course, a few bubbles of gas may pass through without interference but quantities of 20 cubic centimeters or more completely stop its action.

These principles would seem to be clearly brought out in those cases in which siphonage and suction were alternated at different time intervals. Practically no fluid or gas was obtained by siphonage unless it was allowed to proceed some 6 to 9 hours without interruption. During an interval of this length the intermittent effect of siphonage has an opportunity to operate. However, while the internal pressure is being built up to a sufficient height to make the siphonage effective the patient becomes distressed from the accumulating fluid and gas. The patient, N. M. in Table V, demonstrates this point, plainly. Suction in this case was applied for only 10 minutes at a time and only when the patient became distressed from a sensation of fullness or from nausea. Siphonage was allowed to proceed uninterruptedly the remainder of the time. The relief experienced when suction was applied was marked in every instance.

The two cases in which suction was applied for 5 minutes after 48 hours of siphonage illustrate the fact that siphonage is not effective in draining the stomach and duodenum even if allowed to continue for a relatively long time. One must conclude, therefore, that the upper gastro-intestinal tract can not be kept empty or decompressed by siphonage alone; that it affords some relief can not be gainsaid but the addition of mild constant water suction siphonage renders drainage through the duodenal tube much more efficient.

MECHANICAL AND PHYSICAL PRINCIPLES CONCERNED IN DRAINAGE SYSTEMS

Drainage, as it is employed in medicine and surgery depends on one or more of the following principles: (1) capillary attraction, (2) contractility of, and compression by, muscles and other tissues, (3) gravity, (4) siphonage, and (5) some form of constant suction. In draining the cavities of the body, with the exception of the peritoneal cavity, reliance is usually placed on one or more of the 3 last, i.e., gravity, siphonage, or constant suction.

Fluid will always run from a higher level to a lower level when gravity is depended upon for drainage. Therefore, it is essential that the opening through which drainage is expected to take place be located in the most dependent

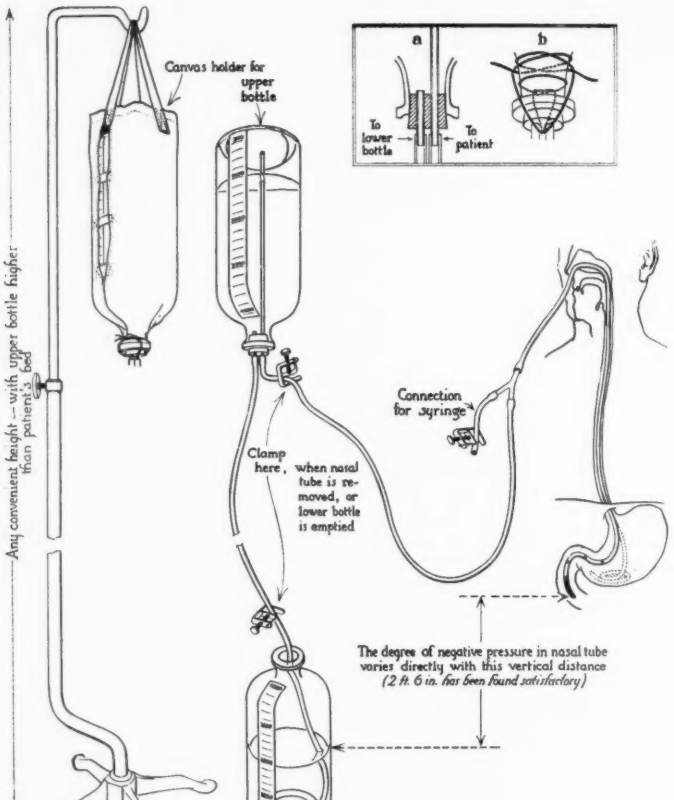

a
b
To lower bottle
To patient
Canvas holder for upper bottle
Any convenient height — with upper bottle higher than patient's bed
Clamp here, when nasal tube is removed, or lower bottle is emptied
Connection for syringe
The degree of negative pressure in nasal tube varies directly with this vertical distance
(2 ft. 6 in. has been found satisfactory)

Fig. 2. Diagram of suction apparatus[1] used in treating postoperative distention, nausea, and vomiting and certain cases of mechanical bowel obstruction; a special, heavy tipped (rubber of higher specific gravity) duodenal tube with perforations continued back 9 or 10 inches is employed. A Y tube connection is attached to the proximal end of the duodenal tube for purposes of irrigation to facilitate freeing it from plugs of mucous which may occasionally interrupt the suction action. A description of this apparatus and the technique of its employment may be found elsewhere (8).

position possible. A tube may or may not be used to carry off the fluid or pus from this opening. Common examples of this type of drainage are thoracotomies for drainage of empyema cavities and drainage of the bladder by a retention catheter. If tubes are employed in this type of drainage an additional factor may come into play. When tubes of large caliber are used and the surface tension of the fluid to be drained is small, drainage usually occurs by the fluid trickling down one side of the tube leaving most of the lumen filled with air. If the drainage tube is of small enough caliber or the surface tension of the fluid great enough a continuous column of fluid will be maintained in the drainage tube. Provided these conditions exist and provided air is prevented from entering the area to be drained either around the outside of the tube or

[1]Assembled by the C. F. Anderson Company, Minneapolis, Minnesota

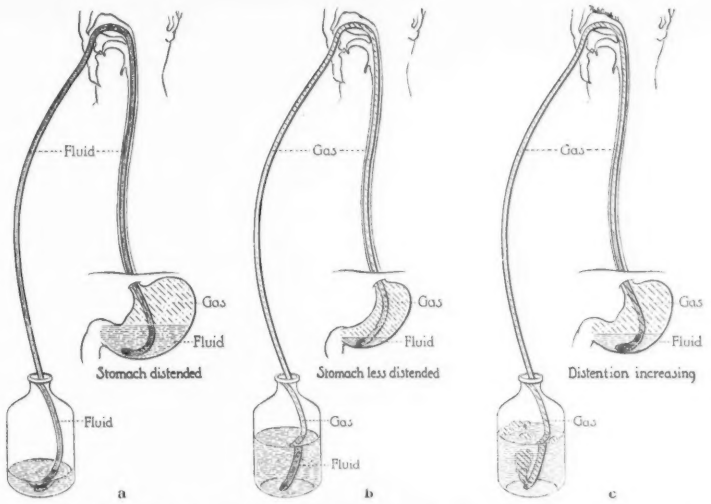


Fig. 3. Drainage of stomach by a duodenal tube acting as a siphon with water sealed drainage: a, Stomach is distended with both fluid and gas. The duodenal tube has been inserted and siphonage instituted. In a stomach with quantities of fluid and gas comparable to those indicated in the diagram considerable fluid will be aspirated. b, Distention is less. Most of the fluid has been evacuated but siphonage stopped as soon as gas entered the duodenal tube. c, Fluid and gas are accumulating in the stomach. Distention will increase until the pressure within the stomach is sufficient to force the gas out of the duodenal tube and to re-establish continuous columns of fluid.

through it, a mild constant negative pressure is developed within the drainage area. The degree of this negative pressure depends on the height of the column of fluid in the drainage tube. The vertical height of the column of fluid in centimeters is approximately equal to the negative pressure in grams per square centimeter.

In order to insure the maintenance of a continuous column of fluid in the drainage tube and hence a negative pressure in the drained area, the principle of water sealed drainage is often applied. This consists of submerging the lower end of the drainage tube in water. Under such circumstances no matter what the caliber of the tube or the surface tension of the fluid, the passage of air into the lumen of the tube is prevented. Such systems are particularly adapted for draining cavities or organs where only fluid is present. For this reason, when it is used clinically, care should be taken to eliminate the entrance of air around the outside of the tube. As previously explained such systems develop negative pressures roughly equivalent to the vertical height of the column of fluid in the drainage tube.

Although in water sealed systems the end of the drainage tube is submerged in water, fluid passing out of the tube meets with no resistance since by the action of gravity, the fluid tends to seek its own level. However, if gas is expected to be evacuated through the submerged tube it must be forced out under a positive pressure equal in grams per square centimeter to the distance in centimeters that the tube is submerged. Instead of creating a negative pressure in the drainage area a positive pressure is created. On this account a water sealed system of drainage is ill adapted for the evacuation of both fluid and gas from any cavity in which gas may be present in quantities of more than a few cubic centimeters at any one time. Of course a few bubbles of gas may pass through the tube without difficulty because the weight of the fluid column behind them will be sufficient to furnish the pressure necessary for their exit from the

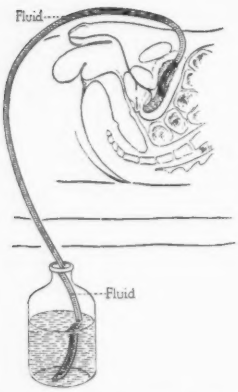


Fig. 4. Water sealed suprapubic bladder drainage in a case of benign hypertrophy of the prostate; drainage is equally effective whether or not a water sealed system is used provided the drainage tube is not of too large a caliber. If a tube of large caliber is used the fluid will run down the side of the tube allowing air to enter the system and decrease the efficiency of the drainage.

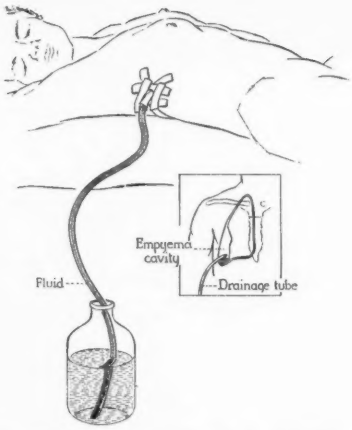


Fig. 5. Water sealed drainage of an empyema cavity. This type of drainage has been found very efficient if a bronchial fistula is not present and provided air is prevented from entering the drainage cavity around the outside of the tube.

submerged tube. At the same time, however, the negative pressure in the drainage cavity is decreased by an equal amount. By analogy, therefore, water sealed systems are not efficient for draining the stomach or other portions of the gastro-intestinal tract.

Drainage by means of a tube used as a siphon is frequently employed clinically especially in draining the stomach and upper gastro-intestinal tract. Many people have used this method believing that its action was continuous and quite efficient. Such a contention is untenable either on theoretical grounds or on the basis of clinical experiment as indicated in this paper.

The siphon is merely a means of obviating the necessity of placing the drainage opening at the most dependent position. Its operation depends upon the existence of two vertical columns of fluid of unequal height connected at the top. A flexible tube the distal end of which is lower than the proximal end fulfills these conditions if it is filled with water. The two columns of water tend to escape through the ends of the tube and in doing so tend to create a vacuum at the top of the system. Both columns of water have the pressure of the atmosphere exerting itself on their lower ends, but since one column is longer and therefore heavier than the other the pressure of the atmosphere becomes apparent only on the shorter column. This column of fluid therefore moves upward to fill the potential vacuum and the longer column moves downward. Thus drainage occurs and will continue as long as there is any fluid in the vicinity of the proximal end of the siphonage tube. A negative pressure then occurs at the proximal end of the tube which equals in grams per square centimeter the difference in height of the two water columns in centimeters. If gas enters the system the siphonage action ceases immediately since the difference in height of the two water columns no longer exists. Of course, as in the water sealed system, a few bubbles of gas can pass through the siphonage tube without stopping its action but a very few cubic centimeters of air or gas are sufficient to interrupt its action.

The operation of the siphon once having been stopped, its action can be started again only by the re-establishment of the two unequal columns of fluid. This can be accomplished either by forcing fluid into the system from either end or by applying suction to either end and thus replacing the gas with fluid. Water or any fluid with a specific gravity approaching that of water may be

raised by siphonage to a height of approximately 32 feet.

Since gas is present in the stomach in considerable quantities from time to time it can be expected to interfere with any form of pure siphonage drainage which may be instituted in an attempt to drain or decompress it. Once stopped, siphonage may be re-established by the accumulation of fluid under a relatively high positive pressure within the stomach or by the momentary application of suction to the distal end of the tube. While time elapses before the intragastric pressure becomes high enough for the siphon to operate spontaneously, the patient is suffering unnecessary distress. For efficient decompression of a gas and fluid containing viscus or cavity such as the intestinal canal, the employment of suction is highly essential.

CONCLUSIONS

1. An inlying duodenal tube used as a siphon is an inefficient means of draining the upper gastro-intestinal tract.

2. Siphonage action is highly efficient in continuous drainage of the urinary bladder and in empyema and other closed body cavities.

3. This difference in the effectiveness of siphonage drainage of the gastro-intestinal canal as contrasted with other body cavities is dependent upon the presence of gas in the alimentary canal which enters the siphonage system and stops its action.

4. The employment of mild continuous water suction siphonage renders drainage of the upper reaches of the gastro-intestinal canal adequate and efficient.

5. The mechanical and physical principles of water sealed and siphon drainage are discussed.

BIBLIOGRAPHY

1. KAPPIS, M. Einige praktische Winke zur Behandlung des peritonitischen Ileus. Muenchen. med. Wchnschr., 1911, lviii, 15.
2. LEVIN, A. L. A new gastro-duodenal catheter. J. Am. M. Ass., 1921, lxxvi, 1007.
3. MCIVER, M. A., BENEDICT, E. B., and CLINE, J. W. Post-operative gaseous distension of the intestine. Arch. Surg., 1926, xiii, 588.
4. PAINE, J. R. Constant suction by nasal catheter as an adjunct in post-operative treatment. Transactions, Minneapolis Surgical Society. Minnesota Med., 1932, xv, 444.
5. PAINE, J. R., CARLSON, H. A., WANGENSTEEN, O. H. A clinical study in the post-operative control of distension, nausea and vomiting: with reference to the employment of narcotics, cathartics, and nasal catheter suction-siphonage. J. Am. M. Ass. In press.
6. WANGENSTEEN, O. H. The early diagnosis of acute intestinal obstruction with comments on pathology and treatment: with a report of successful decompression of three cases of mechanical bowel obstruction by nasal catheter suction-siphonage. Transactions, Western Surgical Society, 1931. West. J. Surg., Obst. & Gynec., 1932, xl 1.
7. Idem. Therapeutic considerations in the management of acute intestinal obstruction. The technique of enterostomy and a further account of decompression by the employment of nasal catheter suction-siphonage. Arch. Surg., 1933, June.
8. WANGENSTEEN, O. H., and PAINE, J. R. Nasal catheter suction-siphonage: its uses and the technic of its employment. Minnesota Med., 1933, xvi, 96.
9. WARD, R. An apparatus for continuous gastric or duodenal lavage. J. Am. M. Ass., 1925, lxxxiv, 1114.
10. WESTERMANN, C. W. J. Ueber die Anwendung des Dauermagenhebers bei der nachbehandlung schwerer Peritonitis faelle. Zentralbl. f. Chir., 1910, xxxvii, 35.

LYMPHATIC PATHOLOGY IN RELATION TO THE "TOXIN" OF BURNS

FREDERICK A. FENDER, M.D.,[1] ROCHESTER, NEW YORK
From The Department of Surgery, The University of Rochester School of Medicine and Dentistry, Rochester, New York

AMONG the less distinguished contributions to the study of any problem are the "negative" findings. They can be said only to mark the blind alleys of investigation, and, perhaps, to aid others in plotting courses toward more productive endeavors.

In the reading of two scholarly papers upon the pathology incident to extensive superficial burns, published now 35 years ago by Dr. Charles Russell Bardeen, we found what appeared to be a fertile field for investigation. And though the result of this investigation is not quite what was expected, it appears to be definite and is, perhaps, worth recording along with a brief review of one aspect of the question.

Bardeen emphasized certain histological changes in the lymphatic structures of the body, notably the spleen, lymph glands, and lymph follicles of the intestines in necropsies upon 5 children who died from extensive superficial burns. Grossly, there was noted softening and enlargement of the spleen and swelling of the lymph glands and intestinal lymph follicles. Microscopically, examination showed focal degeneration of the malpighian corpuscles of the spleen, and swelling and central necrosis in the germinal centers of the lymph follicles. In every instance the œdema was most marked at the germinal centers, and was associated with certain changes in the cells. The protoplasm often was found to be coarse and granular, sometimes vacuolated, and the nuclei in some cases were represented by knotted bands of chromatin. Necrosis, appearing first at the centers, seemed to spread outward, from the centers of the follicles toward the periphery. At a later stage the débris was cleared away from the follicle center, leaving flattened endothelial cells, with thin, faintly staining nuclei. It was thought that these might be the swollen endothelial cells of the lymph spaces.

This central necrosis appeared in varying degrees. It was present in the tonsils and quite marked in the follicles of the gastrointestinal tract. The glandular swelling was thought to be due to swelling of individual cells. Figure 1 shows reproductions of photomicrographs appearing in the original description.

Though Bardeen made it clear that proof for the following was lacking, he invoked the morphology of the lymphatic unit to support this hypothesis: The central artery, running into the center of the follicle, gives off capillaries that are collected into veins at the periphery. The logical route for escaping blood plasma is from within outward. The implication in the foregoing histological picture is that plasma is escaping with more than normal rapidity from the radiating capillaries. The necrosis about the germinal center suggests that the lymphocytes in this region are first subjected to the influence of the escaping plasma, and that destruction may be due to a toxic substance in the blood plasma. Figure 2 is a schematic presentation of the circulatory anatomy of the lymphatic unit, as reconstructed from the account of Calvert and from Lewis and Stoehr's text.

The total pathological picture in the case of fatal burns is rich and varied. Changes may be found in the liver, kidneys, adrenals, lungs, blood, brain and meninges, heart and gastrointestinal tract. Weiskotton and Pack have summarized the chief contributions of this century, and the reader is referred to their articles. However, no observations of a more specific histological nature have appeared since Bardeen published his findings.

Anyone familiar with the voluminous literature on the subject of burns knows of the numerous attempts, in the main unsuccessful, to demonstrate positively a toxin to which may be attributed the clinical course and death of the patient. The predilection for a belief in a toxin apparently arises from the clinician's bewilderment in the face of a potent factor that cannot readily be cata-

[1]Abner Perry Hard Research Fellow in Surgery.

logued or estimated, and from the common use of the adjective "toxic" to describe a patient in poor condition from an unknown cause. This situation, incidentally, is analogous to that surrounding high uncomplicated intestinal obstruction a very few years ago.

Without inclining toward any theory of the causation of death in burns, we felt that Bardeen's findings suggested that a toxin might be formed or at least be present in a high concentration at the site of these more or less specific lesions. Accordingly, the following experimental work was carried out.

EXPERIMENTAL WORK

In 9 experiments grown rabbits were anæsthetized with 0.5 cubic centimeter of a mixture of dial and urethane per kilogram, given intraperitoneally. Hair was removed from one side, from shoulder to rump, by shaving or by a barium sulphide depilatory. That side was treated with the active electrode of an endotherm machine (see Fig. 3). Two animals were killed by bleeding when moribund, after 36 hours—rabbits 90 and 91. The 7 remaining died at intervals of from 12 to 37 hours, the anæsthesia being effective throughout.

At autopsy, specimens of the spleen, small and large intestine, mesenteric lymph nodes, brain, and skin were preserved for examination. These tissues, with the exception of the brain, were fixed in Zenker's fluid, imbedded in paraffin, and stained with hæmatoxylin and eosin. Portions of the brain were variously fixed and stained, and changes noted there may be made the basis for another report.

An extract of each spleen was made and injected intraperitoneally and intravenously into other rabbits. This was carried out in the following fashion. After weighing, the spleen was cut up into small fragments and allowed to stand overnight in 5.0 cubic centimeters of physiological salt solution in an ice box. The following day these fragments were ground in a small mortar and mixed with enough additional salt solution to give a final preparation in which there were 10.0 cubic centimeters for each gram of splenic tissue. This was then filtered through cotton, the last drops being pressed from the mass through the cotton filter. Berkfeld filtration then yielded from 8 to 12 cubic centimeters of a clear, pink or reddish fluid. In defense of the rather large dilution, it may be said that the proponents of the toxin theory generally are looking for a very potent substance, and that if the premise that the toxin was present in high concentration in the spleen had been correct, this dilution should have produced some effect.

TABLE I

Rabbit A		Duration of experiment hrs.	Pathology		Rabbit B		Extract c.cm.		Result of injection
No.	Wt. k		Spl.	L.G.	No.	Wt.k	I. P.	I. V.	
90	2.0	36	+	+	90A	2.4	2.5	3.0	None
91	2.0	36	0	+	91A	2.5	3.0	3.0	None
92	2.5	36	+	+	92A	2.5	5.0	4.0	None
94	3.0	12	+	0	94A	2.8	3.5	4.0	None
95	2.7	20	+	+	95A	3.0	3.1	3.0	None
96	2.4	18	+	+	96A	3.0	5.0	4.0	None
97	2.7	18	+	+	97A	2.2	4.5	3.5	None
98	2.9	37	0	+	98A	2.2	5.0	5.0	None
99	2.3	15	+	+	99A	2.1	4.0	4.0	None

After the taking of cultures, all of which failed to show growth, these extracts were injected intraperitoneally and intravenously into grown rabbits of known weight. The extract of each spleen was divided into two portions; in the first two experiments the intraperitoneal injection was made first, the intravenous 2 hours later. In the others the injections were made in the same order a few minutes apart. From 2.5 to 5.0 cubic centimeters was given intraperitoneally, and from 3.0 to 5.0 cubic centimeters intravenously to each animal.

In no case were we able to observe the slightest effect of any injection.

A tabular record is submitted in order to supply details (Table I).

In the consideration of the pathological changes in the organs of the animals dying after treatment with the endotherm electrode, the states of the spleen and lymph glands seemed most pertinent to this study. As has been seen (Fig. 3), the state of the skin is indistinguishable from that produced by a superficial burn from whatever agent.

In the spleen and lymph glands, œdema, congestion, and small hæmorrhages were the most marked pathological features in all sections. Actual central necrosis of the malpighian corpuscles and lymphatic follicles, as evidenced by gross disorganization recognizable under low power observation, was rare. If the picture was broken up into its component parts, however, after the fashion of McCrae (see below), characteristic changes may be said to have been found in the spleen in 7 instances and in the lymph glands in 8. Both were involved in the same animal in 6 cases. This was true when such criteria were selected as pyknosis of nuclei about the follicle centers, evidence of phagocytosis, hyaline deposits at the centers, fragmentation of nuclei about the centers, increase of endothelial elements. Two sections illustrating these are shown in Figure 4.

It seems fair to conclude from the foregoing that aqueous extracts of the spleens of rabbits, made following treatment of the skin by endothermy, are not clinically toxic when injected into other rabbits.

ALLIED OBSERVATIONS ON LYMPHATIC PATHOLOGY

Statements appearing in papers on burns earlier than those of Bardeen indicate that Avdakoff, Ponfick, Schjerning(45), and Salvioli seem to have noticed, at least grossly, some of the lymphatic tissue changes later described. From the lack of prominence given them, however, one assumes that the importance of the changes was not recognized.

McCrae, in 1901, paid particular attention to lymphatic structures in a series of autopsies upon persons fatally burned. Though he found the lymph glands and spleen involved frequently, he considered that the changes often fell short of necrosis. He divided Bardeen's picture of the characteristic pathology into several component elements, such as evidence of degeneration of lymphocytes, fragmentation of cells at the centers, phagocytosis, and proliferation of large endothelial cells. In cases in which these might be found by high power observation, the appearance upon low power inspection was not typical of central necrosis.

McCrae did not believe that necrosis was the basic mechanism behind these changes. He preferred to interpret the changes as essentially proliferative and affecting the endothelial cells of the reticulum and capillaries. The occurrence of similar proliferative activity of these cells was recalled in the liver shortly after accidental death; in the lymph glands in peritonitis; and in the spleen in myocarditis, chronic tuberculosis, and cerebrospinal meningitis. He draws upon Mallory's description of the proliferative changes in typhoid fever for illustration. In this account the processes are reversed, the necroses being presumed to arise through blocking of the blood sinuses of the spleen by proliferation of endothelial cells.

However, McCrae's differences with Bardeen in regard to lymphatic pathology in burns is limited to the interpretation of the picture seen by both. He, also, believes a toxin to be the cause.

In his consideration of the pathology produced by burns, Weiskotton placed the lymphatic changes among the "more or less characteristic" findings. In his observations, these were represented by evidence of necrosis of the central follicle cells, and were thought to be an early manifestation of the disease process. Lymphatic changes were not prominent in the specimens of Robertson and Boyd, and were thought due to hæmorrhagic infarction by Kolisko. W. Vogt regularly found hyaline infiltration of the smaller arteries of the spleen in his preparations, but did not consider that true central necrosis was present.

Lymphatic pathology of the type described by Bardeen in superficial burns has interested other observers from time to time because of its occurrence in other disease states in which the evidence of a toxin is more concrete. A very attractive line of collateral evidence of an inferential or speculative sort is thus offered on the cause of death in burns.

Thus, somewhat similar changes were produced in 1897 by Simon Flexner with abrin and ricin poisoning. Assuming that the toxins were present in the circulating blood, Flexner suggested that a freer transudation of the toxic material occurred at some sites than at others. Parascandolo cited the similarity between certain effects in burns and those pro-

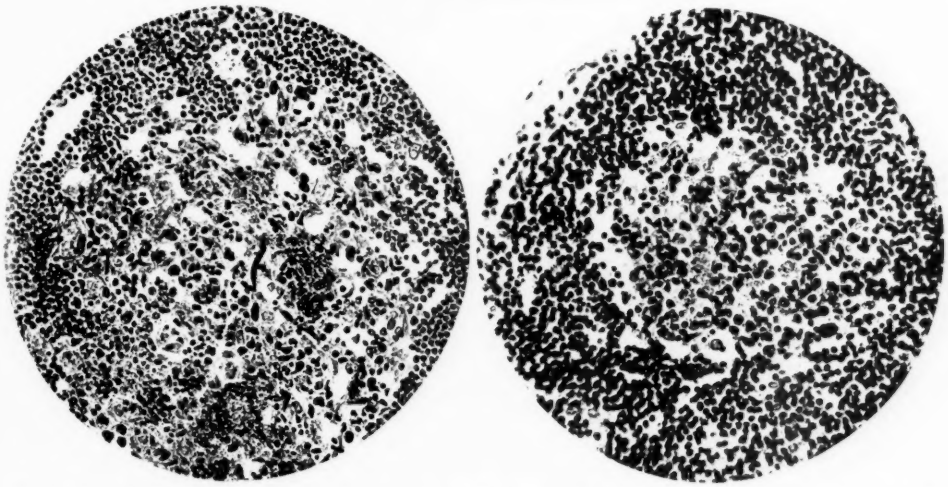


Fig. 1. Reproductions of photomicrographs appearing in Bardeen's original article. A, Left, center of lymph follicle showing well advanced area of focal necrosis; B, center of lymph follicle showing an early stage of focal necrosis.

duced by poisons, mentioning venoms as well as ricin and abrin. Welch and Flexner found approximately the same changes as those noted in burns in experimentally produced diphtheria (63), and, again, produced them by the injection of the "toxalbumin" of the diphtheria bacillus (64).

THE TOXINS OF BURNS

The cause of early death in uncomplicated superficial burns is, of course, unknown at present. The sharpest difference of opinion, perhaps, is upon whether a toxin plays a rôle in the fatal outcome; and since that question seems pertinent to this study, it will be given a brief review.

Neglecting entirely the major question of the cause of death, involving as it does a consideration of several adequate hypotheses not related to toxæmia, it may be well to recapitulate, briefly, some of the substances suggested as toxic agents. This may be interesting because of the diversity of opinions held from time to time, and because of a general trend toward less specific designations. It should be stated that in some cases these substances were not definitely identified, the investigators simply comparing them with a toxin, thus: "muscarin-like," "similar to a ptomaine," etc.

The toxin of burns has appeared to many persons in many guises. Generally speaking, the toxic agent has been supposed to arise from one of three sources: first, from material ordinarily excreted which is retained under the conditions imposed by the burn; second, from decomposition products of burned tissue (including blood) directly; third, from interaction between two or more decomposition products.

A classification of the toxins based upon these supposed sources suggests itself, but this is rendered difficult because of the complexity of some of the theories, and because more than one origin may be postulated in explanation of an hypothesis. Also, instead of aggregating the hypothetical toxins and their mechanisms, we have chosen simply to name the substances. The list follows:

Ammonia, Edenbuizen; ammonia or urea, Billroth; a fibrin ferment, Foà; urea, Ponfick; hydrocyanic acid, Catiano; potassium salts, Schjerning (44); ptomaine, Lustgarten, Kitjanitzin, and Ajello and Parascandolo; pyridine base, Reiss; "hæmolysins and hæmoagglutinins," von Dieterrichs; choline-like substance, Kohlrausch; methyl guanidine, Heyde; diamino acids in alkaline cleavage products, Eden and Herimann; primary and

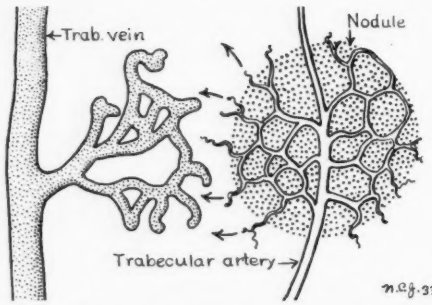


Fig. 2. A schematic presentation of the circulatory anatomy of the lymphatic unit. Reconstructed from diagram in Lewis and Stoehr, and conforming to the account of Calvert.

secondary proteoses, Robertson and Boyd; peptone, Olbrycht; inorganic intracellular material, Turck; unspecified protein cleavage products, Pfeiffer, Fraenkel and Spiegler, Brancati, Il Seung O, Nishimura, and many others; unspecified toxin, Avdakoff, Boyer and Guinard, McCrae, Scholz, Vacarrezza, Bardeen, Weiskotton, Pack, Davidson, Speese and Bothe, Weidenfeld, and many others.

A comparison of dates given in the bibliography shows that the tendency has been toward less narrow definition of the toxic principle. Today the preponderance of opinion among those who consider that toxæmia is responsible for the early clinical manifestations of extensive burns seems to be that the toxin is either the product of protein decomposition or is an unknown substance. In an effort to confirm this statement and to define modern teaching on the subject, we consulted twenty-six surgery texts, in English, that might be expected to consider the question. There was no mention of toxæmia in seven, leaving nineteen that preferred the toxæmia hypothesis. Of these, six indicated a toxin but did not name the agent, twelve named protein decomposition products. Only one went so far as to identify further the toxin, calling it a proteose.

We do not believe that all the experimental work upon which the earlier investigators based their hypotheses can be criticized intelligently at this time. In a few instances, there are obvious weaknesses of method. In others, unwarranted conclusions seem to have been drawn from the data collected. The problem is one that has not found a ready, clear cut experimental approach, and it may suffice to say that in spite of experimentation, earlier workers have failed to convince skeptical observers not only of the rôle of a particular substance advanced, but of the existence of a toxin.

We would like to mention, however, some of the very interesting experiments carried on more recently by several investigators.

Weidenfeld introduced scalded skin into homologous animals subcutaneously and intraperitoneally, and was able to produce death when a certain "dosage," by weight, was reached. Furthermore, he was able to establish a direct proportion between the amount of skin introduced and the speed with which death ensued. The lethal effect was negated by thorough washing of the skin, and by long continued boiling.

Turck ground charred tissue in a mortar, extracted it with water, and injected small amounts of this "solution of tissue ash" into homologous animals intravenously. In 14 animals, symptoms appeared in 30 minutes or less, and 7 of these died in from 10 minutes to 12 hours.

In regard to the work of these two investigators, one can only say that the connection between the experimental conditions and the clinical situation in the case of the burned animal or patient does not seem entirely direct. Underhill, Kapsinow, and Fisk have shown that absorption is very slow and limited indeed, from severely burned areas of skin (55). Histological preparations of severely burned skin show vessels that can hardly be supposed to function. We believe that Weidenfeld and Turck have shown interesting phenomena, but it may not be justifiable to conclude that these are duplicated in the organism clinically. Also, the wide variation in effects of the same dosages of Turck's preparation seems to demand some explanation.

Eduard Vogt found that transplantation of the burned tissues of animals caused the recipient animals to suffer as though from a burn. Animals joined in "skin-muscle" and transperitoneal parabiosis both died when a lethal burn affected one of them. However,

early separation seemed to protect the unburned partner in parabiosis, to some extent.

Little objection has been offered to the experimental methods of Vogt, and indeed our criticism is concerned more with his conclusions than with his experimental work. To be sure, the control element is lacking, and it not infrequently happens that intestinal pathology accounts for death in animals in transperitoneal parabiosis. However, the wide variation in time between operations and experimental work should rule out this possibility unless there were unrecorded deaths in those intervals. As to conclusions, Vogt, and many others whose experiments have been similar, believed he had proved more than he actually had, and subsequent writers have claimed more for him than he himself claimed.

Vogt assumed simply that there was a transfer of the questioned burn toxins from one animal to the other, and that this was more marked in the case of the transperitoneal parabiosis than in the skin muscle type. In regard to the division experiments he stated that the effect of separation after 24 hours of the transperitoneal union was not more effective in saving the life of the unburned partner than separation after 4 days of the skin muscle parabiosis.

In this and other similar experiments it would be more accurate to state that in the secondary animal "a condition leading to death" was produced, or simply that "the animal died." Evidence of a toxin is lacking.

Robertson and Boyd made extracts of the burned skin of animals and were able to produce, by intraperitoneal injection into other animals, appropriate symptoms and death. Their examination of the extracts led them to believe they were dealing, essentially, with primary and secondary proteoses.

The work of Robertson and Boyd has been repeated in a very painstaking fashion by Underhill and Kapsinow (54) who failed, entirely, to confirm it. Apparently alcohol used in preparing the extracts was responsible for a large part of the effects produced.

Vacarrezza, whose work appears to be more widely quoted than read, used a vascular parabiosis in his experiments. He anastomosed the femoral artery and vein of one dog,

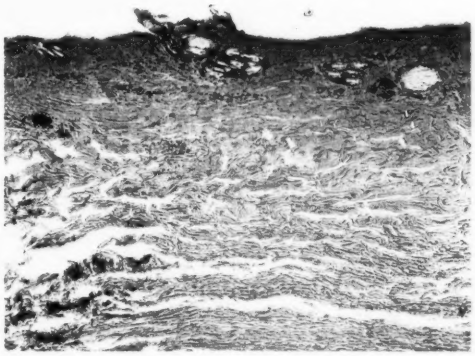


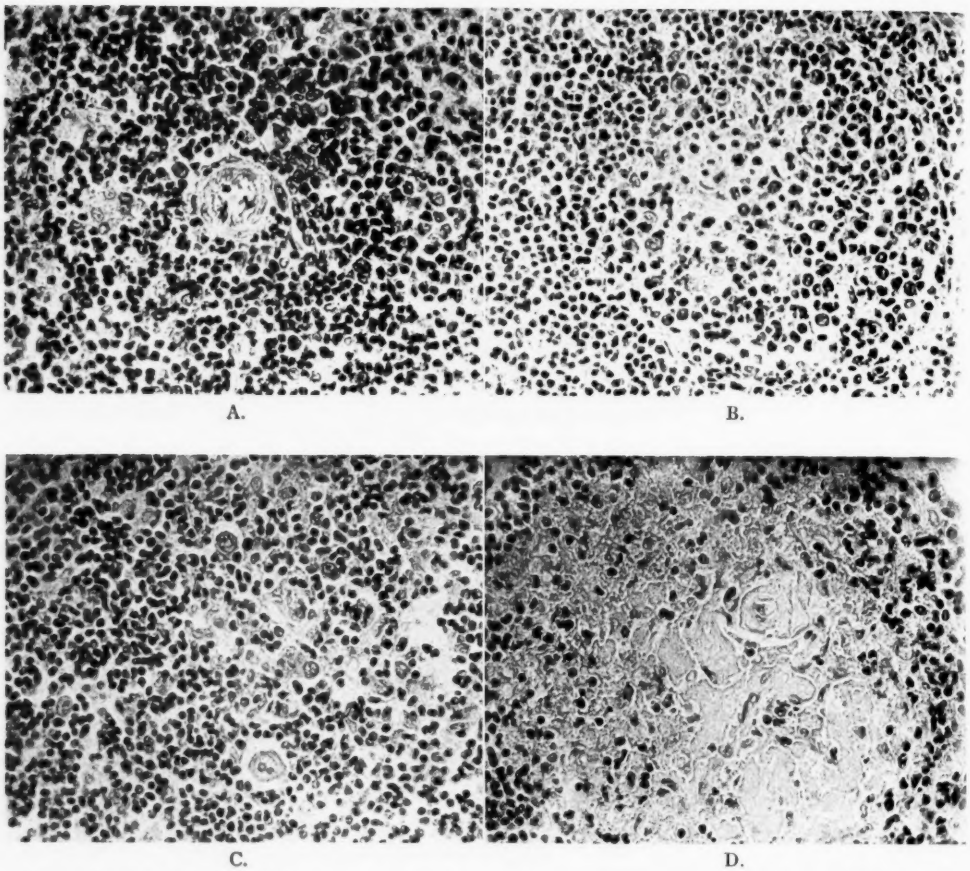
Fig. 3. Low-power photomicrograph of typical section of skin (rabbit 99). Complete destruction extends into the subcutaneous tissues.

"A," with the common carotid artery and jugular vein of another dog "B"—artery to artery and vein to vein. When the leg of "A," thus largely isolated from the vascular system of the animal, was burned, dog "B" died, while "A" lived.

Vacarrezza's arterial and venous anastomoses became thrombosed "within a few hours," presumably in advance of the death of dog "B," which occurred in five and eight hours in the two experiments. The difficulty of carrying out successful anastomoses of this sort, particularly where long immobilization is required, makes control experiments absolutely essential. Again, no necropsies are recorded, and the assumption is that a more obvious cause of death in dog "B" would have been overlooked. Finally, Guptill and the author (work unpublished) have repeated Vacarrezza's experiments without confirming his findings.

COMMENT

Returning, for a moment, to the question of lymphatic pathology; it appears to have been demonstrated that somewhat similar changes appear in the spleen and lymph glands in three types of disease: burns, certain intoxications, and acute infections. Two questions seem strongly suggested: first, are these pathological changes related; that is, do they represent different degrees or phases of one basic process? second, if so, is there an etiological factor or are there etiological factors common to all?



A. B. C. D.

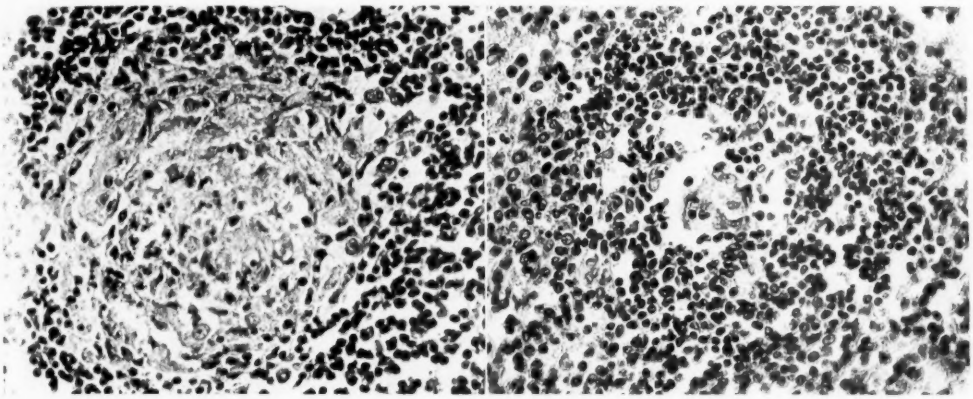
Fig. 4. Varying degrees of changes produced in the germinal centers of mesenteric lymph glands and in the centers of malpighian corpuscles of the spleen in several conditions. A, Spleen of rabbit 96; mild degree of destructive changes, including pyknosis of nuclei about the center, some fragmentation, proliferation of endothelial cells, and phagocytosis. B, Lymph gland of rabbit 92; disorganization at the germinal center, with evidence of degeneration of lymphocytes, phagocytosis, and proliferation. C and D, Sections of lymph gland and spleen, respectively, of patient

The first question can be answered only by the inferences and opinions of those who have made the observations, and these indicate that the processes are related. The second, since it is open to the experimental approach, may eventually be answered with more exactness.

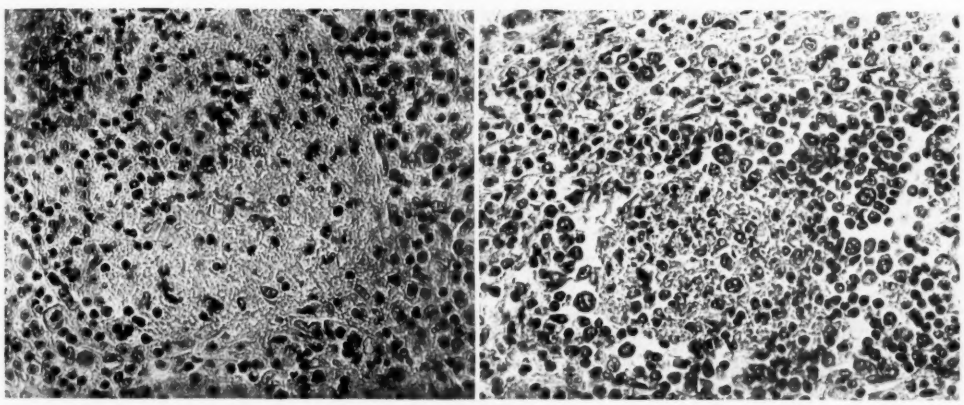
It is a logical speculation that a common factor or common factors may run through these diverse disease states. The first that comes to mind is a toxin. The rôle of a toxin in diphtheria, scarlet fever, etc., is definite, and the acceptance of a toxin as the etiological principle in the lymphatic changes in acute infections, intoxications, and burns is prohibited only by failure to demonstrate it in the latter. For, no matter how attractive the hypothesis is, the toxin of burns cannot be said to have been demonstrated up to the present.

Perhaps hyperthermia is a factor, but from examination of sections of lymph glands and spleens[1] of dogs dying in hyperthermia we have been unable to establish this as a theory thus far. It should be noted that Flexner

[1] Kindly loaned by Dr. Stafford L. Warren.



E. F.



G. H.

dying about a week after an ultraviolet light burn. The changes in the lymph glands were marked enough to classify as frank central necrosis. The malpighian corpuscle shows extensive central hyaline infiltration. E, Lymph gland, and F, spleen from a patient dying of scarlet fever. Focal necrosis and hyaline deposits were quite constant. G, Lymph gland, and H, spleen from a patient dying of diphtheria. Focal necrosis of the germinal centers of the lymph gland and malpighian corpuscles of the spleen well advanced.

experimentally poisoned animals all showed an elevation in temperature.

Dehydration suggests itself as a common factor, as do many of the physical changes in the circulating blood. The common factor may lie in some totally unsuspected mechanism, or there may be none. In any case, it seems fair to hazard the opinion that the demonstration of a connecting link between burns, certain intoxications, and acute infections might lead to a greater knowledge of them all. Photomicrographs are included (Fig. 4) of sections of spleen and mesenteric lymph nodes from patients who died of ultraviolet light burn, scarlet fever, and diphtheria. All show the changes noted above to a greater or less extent.

In regard to the review of work upon toxins, contradictory reports appear, of course, in any extensive experimental study. In the search for a toxin associated with burns, differences of opinion seem traceable to three factors: the lack of a pathognomonic clinical picture; the lack of a pathognomonic pathology; the lee-

way afforded by these two for unwarranted conclusions—and sometimes pure speculation—from experimental results.[1]

CONCLUSIONS

1. In the varied pathological picture produced by superficial burns, lesions in the spleen and lymph glands seem somewhat more specific than others, and the hypothesis has arisen that a potent toxin acts at these sites.

2. Aqueous extracts of the spleens of rabbits treated by an endotherm apparatus failed of toxic effect when injected into other rabbits.

3. A toxin has not been demonstrated to the satisfaction of all in burns, and the theory of causation of death by a toxin cannot be said to rest upon adequate experimental work at present.

BIBLIOGRAPHY

Since the value of any "negative" study is partly in the bibliography, other articles pertinent to the cause of death in burns used in preparing this paper are listed following the references cited.

1. AJELLO, G., and PARASCANDOLO, C. Gazz. d. osp., 1896, xvii, 866.
2. AVDAKOFF, V. Dissertation, St. Petersburg, 1876.
3. BARDEEN, C. R. Exper. Med., 1897, ii, 501; Bull. Johns Hopkins Hosp., 1898, vii, 137.
4. BECKEY, K. Ztschr. f. Geburtsh. u. Gynaek., 1920, lxxxii, 257.
5. BERKOW, S. G. Arch. Surg., 1924, viii, 138.
6. BILLROTH, T. Arch. f. klin. Chir., 1865, vi, 372.
7. BLALOCK, A., BRADBURN, H., JOHNSON, G. S., and HARRIS, P. N. Arch. Surg., 1927, xv, 762; 1929, xix, 725; 1930, xx, 26; 1930, xx, 959; 1931, xxii, 312; 1931, xxii, 598; 1931, xxii, 610.
8. BOYER, J., and GUINARD, L. Des Brulures. Paris: Bailliere, 1895.
9. BRANCATI, R. Policlin. (Sez. Chir.), 1924, xxxi, 233.
10. BRIEGER, L. Weitere Untersuchungen ueber Ptomaine. Berlin: Hirschwald, 1885.
11. CALVERT, W. J. Anat. Anz., 1897, xiii, 174.
12. CATIANO, V. Arch. f. path. Anat., 1882, lxxvii, 345.
13. DAVIDSON, E. C., and MATHEWS, C. W. Arch. Surg., 1927, xv, 265.
14. DAVIDSON, E. D. Arch. Surg., 1926, xiii, 262.
15. DUPUYTREN. Lecons Orales de Clinique Chirurgical. Vol. iv. Paris: Bailliere, 1839.
16. EDEN, R., and HERIMANN, E. Deutsche Ztschr. f. Chir., 1926, cxciv, 303.
17. EDENBUIZEN. Quoted in several early articles. Original manuscripts not available. References: "Beitraege zur Physiologie der Haut." Ztschr. f. rat. Med., 1863, xvii.
18. FLEXNER, S. J. Exper. Med., 1897, ii, 197.
19. FOÀ, P. Riv. sper. di freniat., 1881, vii, 135.
20. FRAENKEL, S., and SPIEGLER, E. Wien. med. Blatt, 1897, xx, 75.
21. GOLDBLATT, D. Ann. Surg., 1927, lxxxv, 490.
22. HARTMAN, F. A., ROSE, W. J., and SMITH, E. P. Am. J. Physiol., 1926, lxxviii, 47.
23. HEYDE, M. Zentralbl. f. Physiol., 1911, xxv, 421; Med. Klin., 1912, v, 263.
24. IL SEUNG O. Keijo J. Med., 1930, i, 229.
25. KITJANITZIN, J. Arch. f. path. Anat., 1893, cxxxi, 46.
26. KOHLRAUSCH. Quoted by Heyde (23). No original publication found.
27. KOLISKO. Vrtljschr. f. gerichtl. Med., 1914, xlvii, 7.
28. LEONARD, V. N., and DAYTON, A. B. Surg., Gyne & Obst., 1917, xxiv, 156.
29. LUSTGARTEN, S. Med. Rec., 1891, xl, 152.
30. MALLORY, F. B. Tr. Ass. Am. Physicians, 1900, xv, 224.
31. MCCRAE, J. Tr. Ass. Am. Physicians, 1901, xvi, 3.
32. MOORHEAD, J. J., and KILLIAN, J. A. Bull. New York Acad. Med., 1927, iii, 401.
33. NISHIMURA, K. J. Chosen Med. Ass., 1932, xxii, 1
34. OLBRYCHT, J. Rev. de méd., 1924, xli, 81.
35. PACK, G. T. Arch. Path. & Lab. Med., 1926, i, 76
36. PARASCANDOLO, KARL. Wien. med. Wchnschr., 1904, liv, 575, 626, 676.
37. PAWLOWSKI, A. D. Atti d. xi Cong. med. internaz., Ripamonte e Columbo, Rome, 1895, iv, 267.
38. PFEIFFER, H. Arch. f. path. Anat., 1906, clxxx, 377; Wien. klin. Wchnschr., 1919, xxxii, 1195.
39. PONFICK. Berl. klin. Wchnschr., 1887, xiv, 672.
40. REISS, W. Wien. med. Wchnschr., 1893, xlv, 59.
41. RIEHL, A. G., JR. Arch. f. exper. Path. u. Pharmakol., 1928, cxxxiv-cxxxv, 369.
42. ROBERTSON, B., and BOYD, G. Am. J. Dis. Child., 1923, xxv, 163; J. Lab. & Clin. Med., 1923, ix, 1.
43. SALVIOLI, I. Arch. per le sc. med., 1891, xv, 157.
44. SCHJERNING. Vrtljschr. f. gerichtl. Med., 1884, xli, 24.
45. Idem. Vrtljschr. f. gerichtl. Med., 1885, xlii, 66.
46. SCHOLZ, E. Muenchen. med. Wchnschr., 1900, xlvii, 152.
47. SCHREINDER, K., and PUCSKO, O. Med. Klin., 1925, xxi, 1882.
48. SIMONART, A. Arch. internat. de pharmacod. et de thérap., 1930, xxxvii, 269.
49. SLOCUM, M., and LIGHTBODY, H. Am. J. Physiol., 1931, xcvi, 35.
50. SPEESE, J., and BOTHE, F. A. Surg. Clin. N. America, 1928, viii, 911.
51. ST. MARKUSFELD, and STEINHAUS, J. Zentralbl. f. allg. Path. u. path. Anat., 1895, vi, 1.
52. TURCK, F. B. Am. J. Surg., 1923, xxxvii, 129.
53. UNDERHILL, F. P., et al. Arch. Int. Med., 1923, xxxii, 31; J. Am. M. Ass., 1930, xcv, 852.
54. UNDERHILL, F. P., and KAPSINOW, R. J. Lab. & Clin. Med., 1931, xvi, 823.
55. UNDERHILL, F. P., KAPSINOW, R., and FISK, M. Am. J. Physiol., 1930, xcv, 302.
56. VACARREZZA, R. A. Rev. Asoc. méd. argent., 1922, xxxv, 48.
57. VOGT, E. Ztschr. f. exper. Path. u. Therap., 1912, xi, 191.
58. VOGT, W. V. Arch. f. path. Anat., 1929, cclxxiii, 1.
59. VON DIETERRICHS, M. Wien. med. Wchnschr., 1903, liii, 2206.
60. VON LESSER, L. Arch. f. path. Anat., 1880, lxxix, 2.
61. WEIDENFELD. Arch. f. Dermat. u. Syph., 1902, lxi, 301.
62. WEISKOTTON, H. G. J. Am. M. Ass., 1919, lxxii, 2.
63. WELCH, W. H., and FLEXNER, S. Bull. Johns Hopkins Hosp., 1891, ii, 107.
64. Idem. Bull. Johns Hopkins Hosp., 1892, iii, 17.
65. WILSON, W. R. Brit. M. J., 1927, i, 54.

[1] The author wishes to acknowledge, gratefully, assistance given by Dr. Anna Popoff in translating Russian, and by Dr. Ignacio Bird-Acosta in translating Spanish.

CÆSAREAN SECTION AT THE BOSTON LYING-IN HOSPITAL

Incidence, Indications, Maternal, and Fetal Mortality—1894 to 1931

JUDSON A. SMITH, M.D., Boston

THE group of cases studied here consists of all the abdominal cæsarean sections performed at the Boston Lying-in Hospital prior to January 1, 1932, except 69 cases which were done definitely before the age of viability for therapeutic abortion. There are 1,556 cases of which 913 were primary cæsarean sections and 643 were repeat cæsarean sections. The primary cæsarean sections are grouped according to the chief indication as follows:

1. Disproportion or cervical dystocia, 527 cases.
2. Heart disease, 95 cases.
3. Toxæmia with or without convulsions or chronic nephritis, 73 cases.
4. Premature separation of the placenta, 76 cases.
5. Placenta prævia, 44 cases.
6. Miscellaneous indications, 98 cases.

These groups are not mutually exclusive but such overlapping as occurs is noted and the groups are defined in detail below.

PRIMARY CÆSAREAN SECTIONS

1. *Disproportion or cervical dystocia.* This group is composed of 527 patients who had vertex presentations and no serious complications (4 had very mild toxæmia, 2 had mitral stenosis without failure, and 1 had both a mild toxæmia and mitral stenosis without failure. No deaths occurred among these 7 patients). An accurate separation of these patients into those who actually had disproportion and those who did not is impossible from a study of the records. They were all subjected to cæsarean section for the purpose of avoiding the risk of a protracted labor or a difficult pelvic delivery and, therefore, represent a definite type of cæsarean section from the standpoint of indication and also of risk.

In the course of 36 years there have been rather marked changes in the incidence of this type of the primary cæsarean, in the management of these cases and in the mortality; changes which are shown in Table I.

It will be noted that in recent years about the same proportion as formerly are done without any test of labor but the average test of labor is much longer and a cæsarean section after rupture of the membranes is now regarded with comparative equanimity.

The causes of maternal death in this group were: sepsis, 12; pulmonary embolus, 2; bronchopneumonia, 2; intestinal obstruction, 1; endocarditis, cerebral embolus, 1. In the last 322 cases (1916–1931) there was but 1 death from sepsis.

Of the 527 infants 7 were stillborn (1.3 per cent) and 17 died (3.2 per cent). Nearly all of the stillbirths occurred after long labors with no other apparent cause. (There were few autopsies.) Lest this be thought a point against prolonging the test of labor, it must be noted that since 1912 (i.e., in the last 404 cases) there were but two stillbirths, both in cases sent in as emergencies in which forceps delivery had been attempted. Of the neonatal deaths 5 were due to congenital abnormalities. Of the 12 others 4 only could possibly have been associated with labor; 1, in 1910, due to "intracranial hæmorrhage" after 4 hours of labor; 1, in 1913, due to "asphyxia" after 46 hours of labor; 1, in 1914, due to "asphyxia" after 18 hours of labor; and 1, in 1918, due to "intracranial hæmorrhage" after 16 hours of labor. In none of these 4 infants was autopsy done. In the past 8 years during which the length of the test of labor in these cases was markedly increased, there have been no neonatal deaths attributable to prolonged labor. A complete discussion of the relation of neonatal mortality and stillbirths to the length of the test of labor should, of course, include a study of fetal results in borderline cases subjected to a test of labor and delivered through the pelvis. We have, however, at this time no data for such a study.

TABLE I.—SUMMARY

	1894–1915 22 yrs.	1916–1923 8 yrs.	1924–1931 8 yrs.
Total number of deliveries	55,715	18,370	24,023
Number of primary cæsarean sections for disproportion or dystocia	205	171	151
Incidence per 1,000 deliveries	3.7	9.3	6.3
Proportion of low type of operation (Beck or Kerr)	0	2%	60%
Proportion examined vaginally	44%	25%	20%
Proportion done after onset of labor	64%	67%	68%
Average hours of labor	10 hr.	9 hr.	17 hr.
Proportion done after rupture of membranes	18%	18%	43%
Average hours after rupture of membranes	7 hr.	8 hr.	12 hr.
Deaths	14	4	0
Mortality	7%	2%	...

2. *Heart disease.* There are 95 cases in which heart disease was the conspicuous indication for cæsarean section. Five of these patients possibly had disproportion and 3 had mild or moderate toxæmia. There were 7 deaths. There are in addition 18 patients with heart disease grouped under other headings as follows: disproportion or dystocia, 3; separation of the placenta, 2; toxæmia or nephritis, 2; repeat cæsarean sections, 11. One of these 18 patients, a chronic nephritic, died of pelvic peritonitis and perinephric abscess. Thus the mortality would remain practically the same (7 per cent) were these patients included in this group. Of the 95 cases, 44 had no heart failure at any time. Of these 44, 1 died of sepsis. Slightly more than half of them were multiparæ and all the multiparæ were sterilized. In these cases the opportunity to resect the tubes seems to have been the principal reason for the cæsarean section.

Of the 95 cases, 51 either had or had had, definite signs of heart failure or seemed to be on the verge of failure. Six of these died, 4 of heart failure, 2 of sepsis. About 60 per cent of these patients were multiparæ and 80 per cent of them were sterilized. Labor is not an important factor in the patients with failure. Only one-quarter of them had any labor at all and those had an average of 8 hours. Only one of the fatal cases had had any labor (5 hours).

The proportion of Class 1 cardiacs delivered by cæsarean section has decreased markedly. From 1920 to 1923, 48 per cent of them were so delivered; from 1924 to 1927, 30 per cent and from 1928 to 1931, only 12 per cent. There are two factors in this decrease. For one thing there has been in recent years less tendency to resort to cæsarean section for patients who have had no sign of heart failure and for another, because of improvement in the prenatal care of our cardiacs, fewer of them have heart failure.

In the group without failure there were 4 babies of whom none were stillborn, and 2 died of prematurity. In the group with failure there were 52 babies (one case of twins). One was stillborn and 11 (21 per cent) died of prematurity.

3. *Eclampsia, toxæmia without convulsions, chronic nephritis.*

a. *Eclampsia.* There were 10 cases of antepartum eclampsia delivered by cæsarean section. Two of these had premature separation of the placenta and are included in that group (both died). Of the 8 other cases, 2 had marked disproportion, 1 was induced by rupture of the membranes but made no progress, and 1 was admitted moribund and was delivered by cæsarean section for the sake of the baby, which survived. Of the 8 patients, 4 died—3 of eclampsia, 1 on the sixteenth day of pneumonia and empyema. Of the 8 infants, 1 was stillborn and 1 (weight 3 pounds, 10 ounces) died on third day in a convulsion.

b. *Toxæmia without convulsions.* There were 52 patients with severe hypertension and albuminuria, but without convincing evidence of chronic nephritis, who were delivered by primary cæsarean section. Five of these probably had some degree of disproportion, 1 had mitral stenosis without failure. Three fourths of them were primiparæ. Six only had started in labor (average 8 hours). Three patients died, 1 of intestinal obstruction, 1 of bronchopneumonia and uræmia, and 1 of postpartum eclampsia. In the group of repeat sections are 5 patients with severe, or moderately severe, toxæmia. None of them died. Inclusion of these cases makes the mortality for cæsarean section in toxæmic cases uncomplicated by convulsions or separation of the

placenta about 5 per cent (3 deaths in 57 cases). The toxæmic patients with separation of the placenta are considered in the next group. Scattered through the other groups are 21 cases with very mild symptoms of toxæmia, among which there were no deaths.

Of the 53 babies (1 case of twins), 1 was stillborn and 4 (8 per cent) died of prematurity.

c. *Chronic nephritis.* There are 13 cases with 2 deaths, 1 from uræmia, 1 from pelvic peritonitis, perinephric abscess, and uræmia. In one of the fatal cases there was rheumatic heart disease. Ten of the patients were multiparæ. Eleven were sterilized. One patient only was in labor, for 1 hour. The predominating motive in delivering these patients by cæsarean section seems to have been the desire to sterilize the patient and to give the premature infants a better chance of survival. As a matter of fact, 8 of the 13 babies died of prematurity. There were no stillbirths.

4. *Premature separation of the placenta.* There are 76 cases of primary cæsarean section for premature separation of the placenta and 2 cases of repeat cæsarean section in which separation had begun. Of the 78 cases, 42 had hypertension and albuminuria. Since this group of 42 patients shows a mortality of 21 per cent (9 deaths) they are reported in some detail. Roughly one-third were primiparæ. Two patients had convulsions antepartum and both died. Thirty-six patients were delivered by the classical operation with 6 deaths; 2 by the Kerr operation with 1 death (in this case hysterectomy was done 7 hours after delivery); and in 4 cases the Porro operation was done with 2 deaths. Thirty-nine were done under nitrous oxide gas oxygen ether anæsthesia with 8 deaths, 3 under local anæsthesia with no deaths, 1 under spinal anæsthesia with 1 death. Three fatal cases and 3 recovered cases were transfused at the time of operation. One fatal case was transfused on the seventh day and 1 recovered case on the twenty-eighth day. The essential facts in the 9 fatal cases are briefly as follows:

1. ix-para. Nephritis. Oliguria. Died on seventh day in uræmia. No autopsy.

2. iv-para. Toxæmia without convulsions. Died suddenly 7 hours after operation without evidence of hæmorrhage. Partial autopsy showed hæmorrhages in liver and severe nephrosis.

3. ii-para. Convulsions. Oliguria. Died on seventh day in coma.

4. i-para. Toxæmia without convulsions. Died on eighth day of peritonitis. Autopsy.

5. i-para. Convulsions. Died 4 hours after operation without evidence of hæmorrhage. Autopsy showed liver necrosis.

6. v-para. Toxæmia without convulsions. Died in 36 hours, anuric, twitching, apparently on verge of convulsions. No autopsy.

7. iii-para. Toxæmia without convulsions. Suppression of urine. Died 3 hours after classical operation. No autopsy. Diagnosis shock. No external hæmorrhage.

8. xii-para. Toxæmia without convulsions. Oliguria. Died on sixth day. Sepsis and uræmia. Autopsy.

9. v-para. Toxæmia without convulsions. Laparotomy 7 hours after delivery because of suspected internal hæmorrhage which was not found. Uterus removed although there had been little external bleeding postpartum. Died on third day. Autopsy showed acute hepatitis and pregnancy nephrosis.

There are three noteworthy facts about this small group of patients. They have an extremely high mortality; hysterectomy is infrequent, although the opportunity afforded of removing the uterus has often been advanced as an argument for delivering this type of case by cæsarean section; there are no deaths clearly due to hæmorrhage. There would seem to be a reasonable doubt as to whether cæsarean section is the best method of delivering these patients.

Of the 36 patients without evidence of toxæmia or nephritis, 3 died, 1 of hæmorrhage and shock, 1 as a result of a severe reaction to transfusion, and 1 of septicæmia. Two of the patients had rheumatic heart disease without failure and both survived. There were 35 classical operations and 1 Porro. Nitrous oxide gas-oxygen ether anæsthesia was used in 33 cases, local anæsthesia in 2, and spinal anæsthesia in 1. All deaths occurred after classical operations under general anæsthesia.

In the toxic group, 76 per cent of the babies and in the non-toxic group 46 per cent of the babies were lost because of non-viability, stillbirth, or death from prematurity.

5. *Placenta prævia.* There are 44 cases of primary section for placenta prævia and 3 cases with placenta prævia in the group of repeat sections. Of the 47 patients, 4 (9 per

cent) died. This figure is no true indication of the mortality to be expected in the treatment of placenta prævia by cæsarean section because the group is so small and 3 of the deaths are due to causes which would, or should, occur but rarely. One patient was moribund from hæmorrhage when admitted, 1 died of hæmorrhage, having bled excessively between the time of examination for diagnosis and the time when preparations for operation were completed, and 1 died of peritonitis and obstruction as a result of a sponge left in the abdomen. The other patient died of sepsis. The trend in this clinic is distinctly in favor of cæsarean section for placenta prævia, complete or partial, when the child is probably viable. Previous to 1928 only an occasional case was delivered by section, while in the 4 years, 1928–1931, 58 per cent of all the prævia cases were delivered by cæsarean section.

Of the 47 babies—1 was non-viable, 2 were stillborn, and 11 died—1 of meningitis, 1 of cerebral hæmorrhage, 1 of cellulitis of face, and 8 of prematurity. Of the 41 babies weighing 4 pounds or more, 9 (22 per cent) were lost.

6. *Miscellaneous indications.* This group is composed of 98 cases of primary cæsarean section which do not fit into any of the other groups of primary section. In 16 cases some degree of disproportion was probably a factor. There were 5 deaths, 4 from sepsis, 1 from shock and hæmorrhage. The indications were as follows: previous gynecological repairs, or vaginal scars, 27 cases (1 death); breech or transverse presentations, 21 cases (1 death); dystocia because of pelvic mass (ovarian cysts, fibroids, prolapsed kidney), 16 cases (1 death); to insure a living child because of age or previous inexplicable stillbirths, 11 cases; pulmonary tuberculosis, 4 cases; contraction ring, 4 cases; previous myomectomy, 2 cases; pyelitis, 2 cases; and 1 case each for the following indications—mistaken diagnosis of cancer of cervix; patient dying of cancer of breast; exophthalmic goiter; diabetes; double cervix and vagina; perforation of lower segment by examining finger; fetal distress early in labor; multiple fibroids; imbecility (1 death from shock and hæmorrhage); carcinoma of ovary (1 death). In one case no indication is to be found in the record. Three of these patients had mild toxæmia and 2 had mitral stenosis without failure.

Of the 99 babies (1 set of twins), 2 were stillborn and 3 died (1 of erysipelas, 1 of hydrocephalus and 1 of bronchopneumonia).

REPEAT CÆSAREANS

In the following discussion it must be borne in mind that the term "cases" refers to cæsarean sections and not to patients. There are 643 cases of repeat cæsarean section which were performed on 446 patients with 22 deaths, a case mortality of 3.4 per cent.

In 475 cases the indication for the primary section is known. Nearly 80 per cent of these 475 cases followed primary sections for disproportion or cervical dystocia. At the present time this ratio is about 50 per cent due to the increase in the number of primary cæsarean sections for other conditions than uncomplicated disproportion and cervical dystocia.

In 35 of the repeat sections there were additional indications as follows: in 5 cases moderate or severe toxæmia; in 5 cases mild toxæmia; in 3 cases placenta prævia; in 11 cases heart disease; in 1 case partial separation of the placenta and toxæmia; in 1 case partial separation of the placenta without toxæmia; and in 3 cases rupture of the uterus. The only death among these 34 cases occurred in 1 case of placenta prævia.

The mortality of repeat sections has not diminished and in recent years has been higher than the mortality of primary cæsarean section for uncomplicated disproportion and cervical dystocia. For the first 22 years it was 2 per cent (2 deaths in 84 cases), for the next 8 years 4 per cent (10 in 262), and for the last 8 years 3 per cent (10 in 297). As noted above, there were 35 cases with complications but these do not account for the higher mortality since death occurred in only 2. If vaginal examinations, labor, and rupture of the membranes are important factors in mortality, the repeat sections are an ideal group, since in the past 16 years (559 cases) only about 1 per cent have been examined vaginally, about 65 per cent have been done before onset of labor and the others on the average 6 hours after, about 90 per cent have

been done before rupture of the membranes and the other 10 per cent on the average 6 hours after. What the factors may be which make repeat section a greater risk than primary section for uncomplicated disproportion or cervical dystocia, it is difficult to say. The causes of death in this group were sepsis, 7; shock and hæmorrhage, 7; lobar pneumonia, 4; bronchopneumonia, 2; intestinal obstruction, 1; acute dilatation of heart and pulmonary œdema, 1. It will be noted that shock and hæmorrhage, which do not appear among the causes of death in group 1 of the primary sections, are a conspicuous cause of death in this group of repeat sections.

Of the 649 infants (6 cases of twins), 7 were stillborn, 1.1 per cent, 28 infants, 4.3 per cent, died—11 of prematurity, 3 of congenital anomalies, 1 of syphilis, 1 of intracranial hæmorrhage, 1 of hæmorrhagic disease, and 11 of obscure causes in most cases considered as status lymphaticus.

Incidence of cæsarean section. The incidence of cæsarean section has been computed for the 6 year period 1894 to 1899 and for each succeeding 4 year period. The results are shown graphically in Figure 1. The basis of the computation is the total number of deliveries in the hospital and the out-patient department and the results shown by the heights of the various columns are expressed in cæsarean sections per thousand deliveries. The numbers above each represent the number of deliveries for the period. The black areas represent the incidence of primary cæsarean for uncomplicated disproportion or cervical dystocia (group 1), the cross hatched areas represent the incidence of primary cæsarean for all other indications, the white areas represent the incidence of repeat cæsarean section.

The rapid and marked increase in the total incidence of cæsarean section and the part played by repeat section in this increase are apparent. As a matter of fact, the total incidence would have decreased considerably in the past 12 years were it not for the fact that an increasing number of repeat sections have been done on patients who had had previous sections done elsewhere. In the last 8 years such cases account for 50 per cent of

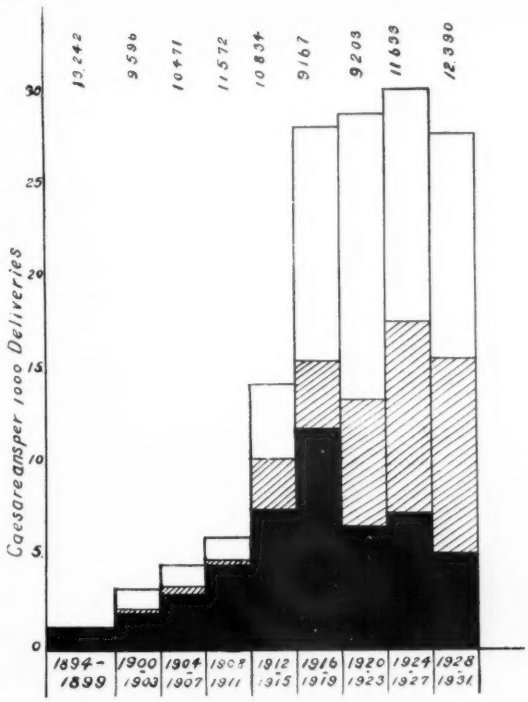


Fig. 1. Incidence of cæsarean section per 1,000 deliveries. Black, primary cæsareans for uncomplicated disproportion or dystocia. Cross-hatched, primary cæsarean for all other indications. White, repeat cæsareans.

the repeat sections. On the other hand, in recent years a smaller proportion than formerly of the patients on whom we did primary cæsarean sections have returned to us for subsequent deliveries. On the whole, therefore, the total incidence is not as useful as the incidence of primary section in showing the trend in the use of the operation. Figure 1 shows that for 16 years the incidence of primary section has remained close to 16 per thousand owing to the increasing use of the operation for indications other than disproportion or cervical dystocia.

The significance of the black areas of Figure 1 is obvious when the type of case represented here is recalled. They show the incidence of the sections for which there was no indication whatever except actual cephalopelvic disproportion, or suspected or alleged disproportion, or the fear of protracted labor. It is not

reasonable to suppose that the incidence of actual disproportion in the clinic population would give a curve like this. Therefore, we attribute the marked decrease in this type of cæsarean to greater discrimination in the selection of cases for section. In recent years this selection has been accomplished mainly by the increasing use in doubtful cases of a thorough test of labor even after rupture of the membranes. There is as yet no evidence of an adverse effect on the mortality.

Mortality. The mortality rates for each of the groups have been stated. Most of these groups are so small that the rates have little significance by themselves. There are, however, some general conclusions in regard to the mortality of cæsarean section which are valid.

The mortality of the whole group of 1,556 cases is 4.9 per cent. Investigation shows that the general mortality has changed but little in the course of years. In the first 328 cases (1894–1915) it was 6.1 per cent. In the next 529 cases (1916–1923) it was 4.5 per cent. In the last 699 cases (1924–1931) it was 4.5 per cent. The mortality has remained at this high figure because of the increased use of the operation in conditions which make the patients bad surgical risks, as is shown by considering the last 699 cases. Of these, 448 were either repeat sections or were primary sections for uncomplicated disproportion or cervical dystocia. These cases had a mortality of 2.2 per cent. The other 251 cases of primary section showed a mortality of 8.8 per cent. Thus there is no point in computing the mortality of cæsarean section in general. For the same reason there is little point in directing attention to the relatively high proportion of maternal deaths which follow cæsarean section, a fact which simply indicates how extensively cæsarean section is used for delivering patients who are gravely ill with heart disease, kidney disease, pre-eclamptic toxæmia, or other disease. Cæsarean section may or may not be the best way of delivering such patients but it will inevitably show a higher mortality in these cases.

Primary cæsarean section on healthy patients now has a mortality in the neighborhood of 1 per cent. It should always be remembered, however, that 1 per cent is a high mortality compared to the risk of easy pelvic delivery in similarly healthy women.

SUMMARY

From 1894 to 1931, inclusive, 1,556 cæsarean sections were done at the Boston Lying-in Hospital, with a mortality of 4.9 per cent. Of these, 913 were primary cæsareans. Of all the primary sections 58 per cent, 527, were done for disproportion or cervical dystocia without other indications or complications. At the present time only about one-third of the primary sections are for this indication. Of the other primary sections 95 were done chiefly for heart disease, 73 for toxæmia or nephritis, 76 for premature separation of the placenta (including some toxic cases), 44 for placenta prævia, and 98 for a variety of miscellaneous indications. The use of cæsarean section for cardiac patients who have not had heart failure and have no other indication has diminished. The use of the cæsarean section for placenta prævia has increased. The incidence of primary cæsarean section for disproportion or cervical dystocia has decreased from a peak of 12 per thousand deliveries 15 years ago to a level of 5 per thousand deliveries during the past 4 years, indicating a much more conservative attitude toward this type of cæsarean section. The total incidence of cæsarean section has been close to 30 per thousand deliveries for 16 years.

About one-half of the cæsarean sections now are repeat sections. Although fewer cæsarean sections are done now for suspected disproportion, the incidence of primary section remains at about 16 per thousand because of the extension of the indications for cæsarean section. The mortality of primary section for uncomplicated disproportion or cervical dystocia is now about 1 per cent. The mortality of repeat cæsarean section is now about 3 per cent. That the mortality in general is now about 4.5 per cent is due mainly to the high death rate in primary section on patients with impaired cardiac or renal function. The infant mortality varies according to the group considered. Following primary section for disproportion it has been about 2 per cent for

the past 16 years, about half the deaths being due to congenital anomalies. In the group of repeat sections during the same period it has been nearly 4 per cent, the increase being due mainly to the larger number of premature infants delivered by repeat cæsarean section. In the groups of toxæmic, nephritic, and cardiac patients there is a high neonatal death rate due to prematurity, which raises some doubt as to whether cæsarean section is any better than pelvic delivery for these premature infants.

GYNECOLOGICAL ASPECTS OF THE ETIOLOGY AND TREATMENT OF CHRONIC MASTITIS

HOWARD C. TAYLOR, JR., NEW YORK
From the Memorial Hospital, New York

THE painful, diffusely swollen or nodular breast is one of a wide variety of conditions which now pass under the name of chronic mastitis. This special form of breast disease is apparently very common, for with a few exceptions the 102 cases of this report were admitted to the Breast Clinic of the Memorial Hospital within a period of only 2 years.

CLINICAL ASPECTS

With the present concentration of interest upon the circumscribed lump and its relation to cancer, there has been a neglect of the diffuse non-surgical forms of chronic mastitis with their interesting symptomatology which is often suggestive of an underlying constitutional disorder. These aspects appear to have been formerly better understood, as is indicated by Astley Cooper's description of "the irritable tumors of the breast," in which he noted particularly the intermittent radiating character of the pain, its exacerbation before the menstrual period, and its special frequency in young women of excitable temperament and abnormal menstrual function. Study of the histories of the present cases shows the accuracy of these observations.

The painful breast is a disorder of relatively young women and its age incidence definitely lower than that of the circumscribed forms of chronic mastitis (Table I).

The proportion of married patients is that to be expected in women of such ages but the frequency of sterile marriage is a little high (Table II).

The presence of pain of more or less severity was the basis for the selection of these patients, for although in all but five abnormalities in consistence were thought to be present, the normal breast is too variable a structure for a dependable diagnosis to be made upon what appear to be minor degrees of increased nodularity. This pain was, as a rule, bilateral and characteristically intermittent, appearing a variable number of days before each menstrual period and improving rapidly after the onset of bleeding. Particularly in the older women, however, frequent exceptions to this rule occurred and the pain was sometimes largely unilateral and nearly constant. Radiation of the pain to points outside of the breast, such as arm, shoulder, and chest wall was present in about a fifth of the cases (Table III).

Beside this cardinal symptom, the following miscellaneous complaints were also noted: temporary but marked premenstrual swelling in 21 and a constant enlargement of one or both breasts in 14 cases; the intermittent appearance of a premenstrual lump in 7 and the presence of a constant lump in 11 cases; secretion from the nipple in 8 and bleeding in 1 case.

The physical characteristics of the breast tissue varied from a practically normal consistence to a nodularity so definite as to require consideration of surgical excision. In the great majority, however, the breast was regarded as moderately abnormal due to the presence of diffusely scattered nodules or of zones particularly in the outer quadrant where faintly

TABLE I.—AGE INCIDENCE

Age in years	Cases
15 to 20	6
21 to 30	38
31 to 40	42
41 to 50	16
Total	102

TABLE II.—MARITAL STATUS AND FERTILITY

	Cases
Single	19
Married—no pregnancies	21
Married—miscarriages only	7
Married with children	55
Total	102

TABLE III.—CHARACTERISTICS OF BREAST PAIN

	Bilateral	Unilateral
Premenstrual	45	16
Constant	13	9
Irregular	13	6

outlined masses could be distinguished from the softer remainder of the breast (Table IV).

When examination was made during the time of the exacerbation of symptoms, the breast was often found to have a tense, swollen appearance not dissimilar from that of early pregnancy, and tenderness was often pronounced. No size or shape of breast appeared especially predisposed to the disease. A marked asymmetry, often of recent origin, however, was common (28 cases) and when this was present symptoms were almost invariably more severe in the larger breast.

PATHOLOGY OF THE PAINFUL BREAST

The pathological basis for this disease is obscure since tissue is rarely available for study. In the cases in which pain and diffuse swelling are the predominant features it is probable that the histological changes consist only in an exaggeration of the variations found in the normal breast in relation to the menstrual cycle. These normal cyclical changes have remained, however, a matter for dispute, and it is undecided whether actual epithelial proliferation or merely a functional reaction occurs before each period (Rosenburg, Dieckmann, Moszkowicz). For the histology of the painful, moderately circumscribed nodules, Sebening has described a state of permanent hyperplasia of the epithelium of the breast lobule in which the normal intermenstrual regression as described by

TABLE IV.—CONSISTENCE OF BREAST TISSUE

	Cases
Normal consistence	5
Generalized "mastitis"	37
"Mastitis" in certain quadrants only	42
Circumscribed nodules	18

TABLE V.—TYPE OF PREVIOUS TREATMENT

	Cases
Excision of chronic mastitis	13
Excision of fibro-adenoma	7
X-ray therapy of breast	7
Diathermy	3
Puerperal inflammation	3
Others	3

Rosenburg fails to occur. He contrasts this condition with the usual histologically recognized forms of chronic mastitis but gives the opinion that transitional forms probably occur and that the epithelial proliferation of the painful nodule may be the precursor of typical chronic mastitis.

That the painful breast is related to several types of new-growth of mammary gland is strongly suggested by study of the present group of cases. In 20 patients previous breast operations had been performed for localized chronic mastitis or fibro-adenoma (Table V). The cases with a recently developed but constant enlargement of one or both breasts suggest also a connection with the so called massive hypertrophy. An immediate relation to cancer is doubtful although in 3 cases observed in the clinic a preliminary error in diagnosis was made when a small malignant tumor was concealed by a diffuse thickening in the outer quadrant which had developed in association with the symptoms of bilateral premenstrual pain and swelling so typical of the benign disease.

ETIOLOGY

By different previous writers the painful breast has been attributed to trauma or inflammation or regarded as a neuralgia or an hysteria, or as a sympathetic response to a primary uterine or ovarian disorder.

The history of a single injury is rarely given (Table VI) but considerable importance has been attached by several writers to the more continuous forms of trauma due to special types of clothing (Snow, Witthauer, Glass) or the repeated minor injuries of a certain occupation (Morgan, D'Anna). That the constant traction of the heavy pendulous breast may

TABLE VI.—CASES ASCRIBING ONSET OF PAINFUL BREAST TO DEFINITE INCIDENT

	Cases
Physiological change	
Puberty	2
Marriage	3
Miscarriage	4
Childbirth	7
Menstrual change	
Change in type of periods	30*
Onset of dysmenorrhœa	2
Pelvic disease	
Onset of pelvic inflammation	3
Operations on adnexa	7
Hysterectomy	6
Local condition	
Breast operation	5
Discovery of lump	2
Trauma	5

*Of these 10 are listed with some other incident also.

TABLE VII.—MENSTRUAL TYPES AT TIME OF FIRST OBSERVATION

	Cases
Summary	
Normal in periodicity and duration	34
Abnormal in periodicity or duration	68
Periodicity	
Normal	57
Short cycle—23 days or less	20
Long cycle—33 days or more	11
Irregular	2
Duration	
Normal	55
8 days or more	8
2 days or less	27
No cycle	
Amenorrhœa	10
Continuous bleeding	2

be an important pain producing factor is shown by the relief which is afforded by proper support (Farrar, Terrillon). In spite of the implication in the term chronic mastitis inflammation is probably not a primary factor although one writer (Glass) maintains his belief in the inflammatory character of certain breast nodules. A less immediate but more demonstrable relationship to inflammation may be found for the pain arising in the scars of incisions for puerperal mastitis (Vignard). The existence of these exciting agents must all be borne in mind for the proper diagnosis of breast pain.

A confusing aspect of the disease is the nervous and mental element which is very prominent in some cases and may make itself apparent in one of three ways: (1) The excitable temperament of the patients has been emphasized by several writers (Cooper, Broca, Snow) and some have even committed themselves to the term, "the hysterical breast" (Michard). Corroboration of their views is found in the alleged development of breast symptoms after a psychic shock (Féré) or during a period of special nervous tension (Rosenthal). Further evidence of a nervous instability is found in the associated symptoms of nervous disorder frequently observed in these patients, such as palpitation and precordial pain (Wewer), dysmenorrhœa (Dietrich and Frangenheim), and various gastrointestinal disorders (Cooper). (2) Suggestion appears often to play an important rôle for in many cases breast pain will long persist after a trivial injury, or will begin simultaneously with the discovery of a minute or merely fancied lump or follow the excision of a small benign tumor. An increasingly fertile source of breast pain is now the fear of cancer, particularly in women who have witnessed the course of the disease in a member of their family. (3) The frequent radiation of the pain to points beyond the breast and the occasional limitation of the tenderness to the skin instead of the parenchyma of the breast has lead to the concept of the pain as a neuralgia (Terrillon, Rosenthal, Witthauer). The view is supported by the alleged existence of fixed points of tenderness (Valleix) and by the rare association of breast pain with herpes zoster (Alfter) and tabes dorsalis (Preuss and Jacoby).

The striking increase in the severity of the symptoms before menstruation has led many writers to search for evidence of uterine or ovarian abnormalities. The older writers, such as Cooper and Velpeau, were very positive in their belief that pain in the breast was associated with disordered, in particular scanty or delayed, menstruation, and subsequent writers have adhered to this belief (Copland, Witthauer, Rosenthal, Miller).

Beside the abnormalities of menstruation, organic pelvic disease has been referred to as the cause of the painful and nodular breast, and one finds mentioned in the literature such diverse conditions as the following: malpositions of the uterus (Hastrup, Ayler, Miller), developmental defects (Miller, Snow), hypertrophy of the cervix (Copland), inflammations

TABLE VIII.—TYPES OF LACTATION

	Cases
Childless women	47
Lactations all normal	20
Lactations all deficient (less than 6 months)	22
Some lactations normal, some deficient	7
No information	6

TABLE IX.—INTERVAL BETWEEN BIRTH OF LAST CHILD AND ADMISSION TO BREAST CLINIC

	Cases
Under 1 year	1
13 to 35 months	4
3 to 5 years	12
6 to 10 years	18
Over 10 years	13
No information	7

TABLE X.—SUMMARY OF PELVIC LESIONS

	Cases
Normal pelvis	
No examination	13
Normal examination	16
Pelvic tumors	
Fibromyoma	11
Cyst of ovary	1
Carcinoma of corpus	1
Displacements and lacerations	
Retroversion or prolapse	16
Retroversion and cervical laceration	10
Cervical laceration	6
Pelvic inflammation	
Chronic salpingo-oophoritis	7
Parametritis, pelvic congestion	3
Previous pelvic operations	
Hysterectomy	9
Operations on adnexa	9

(English), fibromyomata (Miller), tumors of the ovary (Giordano, Muellerheim), and persistent corpora lutea (Samuel, Leriche). Many other writers, although less specific, have listed the search for pelvic lesions as one of the primary steps in the treatment of the painful breast or have reported improvement after the cure of gynecological disease.

ETIOLOGICAL EVIDENCE FROM THE PRESENT CASES

In 66 of the cases of the present study, it was possible either by the patient's own report or by a study of her history to assign the onset of the breast pain to a special incident in her life. Except in the case of pelvic operations where a 2 year limit was used, the pain in the breast began within a few months after the various events, accidents, or physiological changes which are noted in Table VI. The great frequency with which changes in the type of menstruation are followed by the onset of breast pain is noteworthy.

TABLE XI.—PATHOLOGY OF OVARIES AS NOTED AT OPERATION

	Cases
Normal	
No note	1
"Normal"	1
Abnormalities in size	
Both large	2
Both small	2
One small	4
Cystic abnormalities	
Single cyst	4
Multiple microcysts	3
Large cystic corpora lutea	4
Inflammation	
Salpingo-oophoritis	3

Analysis of the menstrual types in these patients showed that a large percentage were suffering from some abnormality at the time of their application to the clinic for relief of breast symptoms (Table VII).

The history of lactation among the parous women showed slight evidence of a deficient breast function (Table VIII).

In view of the relative youth of these patients it was striking to find that at least 90 per cent of the previously fertile women had had no child for at least 3 years and in the great majority the interval was much longer.

Subsequent search for the reason for this secondary infertility among 55 married women with breast pain indicated that sterility was rarely the cause and that the use of contraceptive measures of a type notoriously prone to produce pelvic congestions and nervous disorders in women was the rule (Table IX).

The rôle of abnormalities of the sexual function in the production of breast symptoms has already received some attention in the literature. Samuel has briefly described several cases of mastodynia and secretion from the nipple resulting from abnormal breast stimulation and in the German writings there is recurrent reference to the occasional painful swelling of the breasts in adolescent males which has been ascribed to masturbation (Glass, Rosenthal, Witthauer, de Quervain). Dickinson, who has observed certain cases of chronic mastitis over a period of many years and diagrammatically recorded in great detail

TABLE XII.—EFFECT OF VARIOUS TYPES OF TREATMENT

	Total	Cured	Improved	No change
Simple observation	20	4	11	5
Observation through pregnancy	3	3	0	0
Observation through menopause	3	1	2	0
Gynecologic operation	16	6	9	1
Non-operative gynecological therapy	8	2	5	1
Irradiation of ovaries	13	8	4	1
Ovarian extracts by mouth	39	7	21	11

TABLE XIII.—EFFECT ON BREAST OF OPERATIVE TREATMENT OF PELVIC LESIONS

	Cured	Improved	No change
Operations in which fibroids were removed			
Hysterectomy, bilateral salpingo-oophorectomy	0	1	0
Hysterectomy, unilateral salpingo-oophorectomy	1	0	0
Hysterectomy	1	0	0
Myomectomy. suspension, unilateral salpingo-oophorectomy	1	1	0
Myomectomy, suspension	0	2	0
Myomectomy	0	0	1
Operations, chiefly for uterine malposition			
Suspension, unilateral salpingo-oophorectomy	0	2	0
Suspension	2	2	0
Operations chiefly for chronic inflammation			
Bilateral salpingectomy, unilateral oophorectomy	0	1	0
Bilateral salpingectomy	1	0	0

TABLE XIV.—EFFECT ON BREAST OF NON-OPERATIVE PELVIC TREATMENTS

	Cured	Improved	No change
Pelvic inflammatory disease	1	2	0
Parametritis, pelvic congestion, dyspareunia	1	3	0
Cervical erosion, endocervicitis	1	0	0

TABLE XV.—EFFECT OF TREATMENT BY OVARIAN SUBSTANCE

	Cured	Improved	No change
Young single women	0	5	5
No significant pelvic lesion	1	7	2
Previous pelvic operation	3	2	3
Definite pelvic lesion	3	7	1

the fluctuations in the size of the nodules also believes that self excitation may be an important causative agent. No systematic attempt to pursue the subject further has been made but without special effort enough evidence has accumulated from several cases to indicate that research in this obscure field might yield important information upon the cause of various forms of breast disorder.

Pelvic examination on these patients yielded a diversity of lesions in general similar to those referred to by Miller. All of the conditions listed in Table X were very definite and with the exception of 8 uncomplicated, symptomless retroversions and the cases with histories of previous pelvic operations were such that some form of coincident gynecological therapy was to be recommended.

The chief additions to the pathology of the pelvic organs afforded by the 16 gynecological operations performed after the onset of the breast symptoms, concerned the ovaries. These were observed by the writer in only 10 instances and in the other cases data depend upon the reports of other operators.

These findings offer no satisfactory explanation of the breast pain. Both the cysts and the large corpora lutea are interesting but of doubtful significance owing to their general frequency. To the number of cases with cystic ovaries must perhaps be added, however, the 9 cases complaining of breast pain after hysterectomy. The relative frequency of this type of case is in itself striking. In all of the 9 cases adequate information could be obtained to prove satisfactorily that one or both ovaries had been preserved. That small cysts may develop in the retained ovaries after hysterectomy is recognized clinically (Vineberg) and has been demonstrated on certain animals (Lindig, Zimmermann). The improvement in breast symptoms when these retained ovaries were treated by X-ray represented perhaps the most striking therapeutic result that was observed in any of these cases.

SUMMARY OF CAUSES

The exacerbation of symptoms before the menstrual periods suggests an endocrine basis for the painful nodular breast. The evidence of a frequently disturbed menstruation and the relief afforded by X-ray treatment of the ovaries favor this view. A consistent pelvic lesion is not, however, found. A few cases with small ovarian cysts alone offer a logical explanation of the symptoms on the basis of a disorder of the ovaries. For the other cases, the patients with fibroids, with retroversions or lacerations or with parametritis and inflammation of the adnexa, no single lesion except the vague condition implied by the term chronic pelvic congestion, can be universally applied. If these pelvic lesions are the basis of the breast disorder, the mechanism through which the breasts are affected remains undetermined.

TABLE XVI.—SUMMARY OF SUCCESS IN TREATMENT OF BREAST SYMPTOMS IN RELATION TO TYPES OF MENSTRUAL DISORDERS

	Total				Normal and abnormal menstruation						Variations in length of cycle												Variations in duration of bleeding									No cycle					
					Normal in periodicity and amount			Abnormal in periodicity or amount			Normal periodicity			Cycle too short 23 days or less or 21–28 days			Cycle too long 33 days or more or 28–35 days			Irregular 21–35 days			Normal in duration or amount of flow			Too much bleeding 8 days or more excessive			Too little bleeding 2 days or less scant			Amenorrhœa			Continuous bleeding		
	Total cases	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change
Observation:—																																						
A. Young single women	5	1	1	3	1				1	3	1		3		1								1	1						3							
B. No definite pelvic abnormality	6	1	5		1	1			4		1	2			2			1					1	4						1							
C. Previous gynecological operation	1	1						1																							1						
D. Definite pelvic lesion	8	1	5	2		1	1	1	4	1		3	1		1	1	1	1					1	2	1			1		3							
	20	4	11	5	2	2	1	2	9	4	2	5	4		4	1	1	2					3	7	1			1		4	3	1					
Special observation:																																						
E. Pregnancy	3	3			3						3												3										1				
F. Menopause	3	1	2					1	2			1					1						1							1			1				
	6	4	2	0	3			1	2		3	1					1						4							1			1				
Gynecological operation	16	6	9	1		3		6	6	1	3	5		1	2	1	2	1			1		1	3		3	2	1	2	4							
Non-operative gynecological therapy	8	2	5	1		3	1	2	2			4	1	1	1		1						2	3	1					2							
Radiation of ovary																																						
A. Women approaching menopause	4	2	1	1				2	1	1	1				1		1						1	1		1						4	2	1			
B. Previous hysterectomy	6	4	2					4	2																												
C. Coincident pelvic lesion	3	2	1					2	1					1									1											1	1	
	13	8	4	1				8	4	1	1			1	1		1						2	1		1						4	2	1		1	1
Ovarian substance																																						
A Young single women	10		5	5		4	1		1	4		4	2		1	1			1					5	2					3							
B. No definite pelvic abnormality	10	1	7	2		3	1	1	4	1	1	6	2					1						4	1				1	3	1					
C. Previous gynecologic operation	8	3	2	3	1		2	2	2	1	2	1	3	1									2		2				1	1	1		1			
D. Definite pelvic lesion	11	3	7	1	1	5	1	2	2	0	1	5	1	2	2	0							3	7	1											
	39	7	21	11	2	12	5	5	9	6	4	16	8	3	3	1		1	1			1	5	16	6				2	4	5		1			
Total	102	31	52	19	7	20	7	24	32	12	13	31	13	6	11	3	6	4	1		1	1	17	30	8	4	2	2	4	15	8	5	4	1		1	1

TABLE XVII.—SUMMARY OF SUCCESS IN TREATMENT OF BREAST SYMPTOMS IN RELATION TO GROSS LESIONS OF PELVIC ORGANS.

	Totals				Normal pelves						Pelvic tumors									Displacements and lacerations									Inflammation						Previous pelvic operations					
					No examination made			Pelvic organs normal			Fibromyoma			Cyst of ovary			Carcinoma of corpus			Retroversion or partial prolapse			Retroversion and cervical laceration			Cervical laceration or erosion			Chronic salpingo-oophoritis			Parametritis pelvic congestion			Previous hysterectomy			Previous adnexal operation		
	Total	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change	Cured	Improved	No change
Observation																																								
A. Young single women	5	1	1	3	1	1	1															1					1													
B. No significant pelvic lesion	6	1	5		1	1			3											1																				
C. Previous gynecological operation	1	1																																	1					
D. Definite pelvic lesion	8	1	5	2								1	1							1				3			1			1										
	20	4	11	5	2	2	1		3			1	1							1	1	1		5			2			1					1					
Special observation																																								
E. Pregnancy	3	3			1			1																														1		
F. Menopause	3	1	2		1				1											1																			
	6	4	2		2			1	1											1																	1		
Gynecological operation	16	6	9	1							3	3	1							1	2		1	3					1	1										
Non-operative gynecological therapy	8	2	5	1																				1			1	2		1	2								
Radiation of ovary																																								
A. Women approaching menopause	4	2	1	1				1												1	1																		1
B. Previous hysterectomy	6	4	2	0																															4	2				
C. Coincident pelvic lesion	3	2	1	0							1						1																			1				
	13	8	4	1				1			1						1			1	1															4	3				1
Ovarian substance																																								
A. Young single women	10		5	5		3	3		2	2																														
B. No significant pelvic lesion	10	1	7	2					5	1										1	2	1																	
C. Previous gynecological operation	8	3	2	3								1						1			3		1	1		2	1			1					1		3	1	3
D. Definite pelvic lesion	11	3	7	1																																				
	39	7	21	11		3	3		7	3		1				1				1	5	1	1	1		2	1			1					1		3	1	3
Total	102	31	52	19	4	5	4	2	11	3	4	5	2			1	1			4	10	2	2	8		2	1	3	2	5		1	2		5	4		4	1	4

TREATMENT

The 102 cases of the present report have been treated by one of five methods now to be described. The average period of observation after the beginning of treatment was 10 months. The success of treatment as shown in Table XII was determined chiefly by the effect upon the symptom of pain since minor variations in the consistence of the breast offer too great a temptation to the optimistic therapeutist and are certainly of no value unless comparative observations are made in the same phase of the menstrual month. When unmistakable changes in the physical character of the breasts occurred these will be referred to.

Group 1. Observation alone. The 20 cases observed without treatment over a period of some months demonstrate that the breast symptoms have a marked tendency to spontaneous improvement which makes difficult the evaluation of any special form of therapy. Subdivision of these cases (see Tables XVI, XVII) shows only that in the group of single women under 30 years of age the symptoms were especially persistent.

The two small groups of cases observed either before and after pregnancy or before and after the menopause demonstrate the relatively profound effect of physiological processes as compared with artificial therapeutic agents. In these cases the disappearance of nodules and softening of the breast were unmistakable.

Group 2. Operation. The results of operative treatment tend to confirm Miller's statement that improvement in the breast may be expected after myomectomy, the correction of displacements, and the cure of adnexal disease. The single complete failure in this group was in a case in which the operation failed also in the control of the uterine bleeding for which radium was subsequently employed.

Group 3. Non-operative gynecological therapy. The 8 cases of this group were essentially patients with chronic pelvic inflammation of gonorrhœal origin and those with diffuse pelvic tenderness due to parametritis from cervical lacerations or infections. The types of therapy were simple, pelvic diathermy, cauterization of the cervix or a course of tampon and douche treatments. The tendency to improvement here also appears to be slightly greater than for the observation group.

Group 4. Radiation of ovaries. The readily demonstrable improvement in chronic mastitis after the normal cessation of the periods led to the consideration of the artificial menopause as a means of treatment. The radical character of this procedure made it applicable only to certain cases and the 13 of this report fall into one of three definite groups: (1) women over 45 or those over 40 in whom the onset of the menopause is already suggested by irregularity of the periods; (2) women in whom the uterus has been removed; (3) women with coincident pelvic disease which itself requires radiation.

The results of treatment by irradiation of the ovaries were convincing and a complete disappearance of breast symptoms was attained in 8 of the 13 cases. This improvement was the more striking since the most marked examples of constant tenderness and breast swelling were found in the patients treated by this means. Subsidence of swelling and symptomatic relief began within a few days of the first treatment. The only complete failure among the radiated cases was in a woman suffering from a localized breast pain, whose sister had died recently of cancer, and who was treated, probably illogically, by radiation of the ovaries 4 years after her last menstrual period.

At first the X-ray dosage was calculated to produce complete cessation of the ovarian function. In 5 of the later cases, in an attempt to avoid the troublesome symptoms of the menopause, smaller doses were given. Definite improvement in breast symptoms in 2 cases followed a single high voltage treatment of 200 r units without the production of the distressing vasomotor symptoms. In 3 cases treated by relatively light irradiation there was noted after a lapse of several months, a partial return of breast symptoms which in 2 cases was very slight and in 1 was successfully treated by a second administration of X-rays to the ovaries.

The cautious extension of the principle of small doses of X-rays to the ovaries of some-

what younger women if they intend no further children, is to be considered.

TREATMENT BY OVARIAN SUBSTANCE

Since the time of Cooper, attempts have been made to influence the breast condition through the correction of the disturbed menstrual function. Cooper himself recommended iron and hot baths. Velpeau proposed the application from time to time of a few leeches to the vulva! More recently favorable reports have been made upon the use of organ extracts (Schweitzer, Bainbridge, Lisser, Cutler).

The extremely favorable report of Cutler upon the use of ovarian residue by mouth led us to an extensive trial of ovarian preparations. With the relation of the exacerbations of pain to the periods in mind, tablets of ovarian residue or of whole ovarian extracts were prescribed in daily doses of 15 grains during the 10 days before the onset of each expected menstruation.

The results as summarized in Table XV show that the percentage of cured and improved cases was practically the same as in the group observed without treatment for a like period. To this practical demonstration of failure the point must be added that the use of ovarian substance or residue is quite empiric since no deficiency in hormone has yet been demonstrated. Furthermore, were a deficiency present the type of substance used in this and previously reported series must now be regarded as utterly inadequate significantly to increase the patient's supply of ovarian hormone. The administration by hypodermic injection of follicular and anterior pituitary hormones is now being tried in the clinic.

SUMMARY OF TREATMENT

1. Chronic mastitis of the type characterized by pain, ill defined nodules, and diffuse swelling has a marked tendency to spontaneous improvement.

2. Following the physiological changes of pregnancy or the menopause, improvement may be especially marked.

3. The elimination of pelvic lesions either by surgical or non-surgical treatment is followed by a somewhat greater percentage of cures than is observation alone. When important pelvic lesions exist their correction should be the first step in the treatment of diffuse mastitis of the type under consideration.

4. Irradiation of the ovaries either with the production of an artificial menopause or by a smaller dose is very effective although applicable only to certain cases.

5. The administration by mouth of the older forms of ovarian extract or residue is useless. Trial of more potent modern preparations of follicular and anterior pituitary hormones is indicated in the cases in which breast symptoms are associated with disturbed menstruation.

BIBLIOGRAPHY

1. ALFTER, L. Neuralgia mammarum. Allg. med. Centr.-Ztg., 1856, xxv, 193–195.
2. AYLER, J. W. Case of inveterate mammary neuralgia, due to unsuspected uterine version. Virginia M. Month., 1878, v, 115–117.
3. BROCA, P. Sur le traitement des adénomes et des tumeurs irritables de la mamelle par la compression. Bull. gén. de thérap., 1862, lxii, 154.
4. CABOT, R. C. Irritable breasts or chronic lobular mastitis. Boston M. & S. J., 1900, cxliii, 555. Discussion, 557.
5. COOPER, SIR A. P. Illustrations of the Diseases of the Breast. Chap. ix, p. 76. London: Longmans Green & Company, 1829.
6. COPLAND, J. A Dictionary of Practical Medicine. Vol. v, 929, 936. New York: Harper, 1860.
7. CUTLER, M. The causes of "painful breast" and treatment by means of ovarian residue. J. Am. M. Ass., 1931, xcvi, 1201–1205.
8. D'ANNA, E. La mastite professionale. Clin. chir., 1910, xviii, 1655–1660.
9. DIECKMANN, H. Ueber die Histologie der Brustdruese bei gestoertem und ungestoertem Menstruations ablauf. Arch. f. path. Anat., 1925, cclvi, 321.
10. DIETRICH, A., and FRANGENHEIM, P. Die Erkrankungen der Brustdruese. Stuttgart: Enke, 1926.
11. DICKINSON, ROBERT L. Personal communication.
12. DUFOURT, P. Sécrétion mammaire consécutive à l'hystérectomie totale avec castration double. Lyon méd., 1913, cxx, 959.
13. ENGLISH, T. C. Mammary neuralgia, with remarks on treatment. Treatment, 1906, x, 81–84.
14. ERNST, M. Experimentelle Untersuchungen und klinische Beobachtungen ueber Entnervung der weiblichen Brustdruese. Deutsche Ztschr. f. Chir., 1929, ccxv, 302–308.
15. FARRAR, L. K. P. Nonmalignant nodules of the breast the result of prolapse. J. Am. M. Ass., 1930, xcv, 1329–1332.
16. FÉRÉ, C. La pathologie des émotions. p. 248. Paris: Alcan, 1892.
17. FITZWILLIAMS, D. C. L. The "hysterical breast." Post-Grad. M. J., 1928, iii, 138–142.
18. GIORDANO, D. Sympathie génito-mammaire. Arch. franco-belges de chir., 1928, xxxi, 647–652.

19. GLASS, E. Zur Frage der entzuendlichen Geschwuelste der Mamma. Deutsche med. Wchnschr., 1921, xlvii, 1585–1586.
20. Idem. Weitere Beobachtungen ueber das Krankheitsbild der subakuten Mastitis mit Knotenbildung in der Mamma. Deutsche med. Wchnschr., 1923, xlix, 275–276.
21. HASTRUP, R. Et Tilfaelde af Mastodyni. Hosp.-tid. 1911, iv, 1521–1527.
22. HENKEL, M. Ueber die Wechselbeziehung zwischen Uterus und Ovarien, ein Beitrag zur Behandlung gynaekologischer Blutungen. Muenchen. med. Wchnschr., 1911, lviii, 337–340.
23. KUECKENS, H. Zur Frage der zyklischen Veraenderungen der Mamma und des menschlichen Scheidenepithels. Ztschr. f. Geburtsh. u. Gynaek., 1929, xcvi, 55–76.
24. LERICHE, R. Hypertrophie mammaire douloureuse, flétrie par castration. Lyon chir., 1923, xx, 653–655.
25. LINDIG, P. Funktionsaeusserungen und -bedingungen des isolierten Eierstockes. Arch. f. Gynaek., 1922, cxvii, 289–294.
26. LISSER, H. A note on the use of corpus luteum to prevent the painful breasts of menstruation. Endocrinology, 1918, ii, 12–15.
27. LUCHSINGER y CENTENO, J. Ueber die cyklischen Veraenderungen der weiblichen Brustdruese. Beitr. z. path. Anat. u. z. allg. Path., 1927, lxxviii, 594–617.
28. MILLER, C. J. Pelvic lesions as a contributing factor in chronic cystic mastitis. Am. J. Obst. & Gynec., 1925, x, 375–379. Discussion, 437. Tr. Am. Gynec. Soc., 1925, l, 138–145.
29. MORGAN, J. H. Cases of painful mamma in young girls. Brit. M. J., 1885, ii, 738.
30. MOSZKOWICZ, L. Ueber den monatlichen Zyklus der Brustdruese. Arch. f. klin. Chir., 1926, cxlii, 374–418.
31. MUELLERHEIM, R. Ovarialtumoren bei Greisinnen mit Hypertrophie der Mammae und des Uterus und mit uterinen Blutungen. Zentralbl. f. Gynaek., 1928, lii, 689–693.
32. PREUSS, J., and JACOBY, A. Mammakrisen bei Tabes. Med. Klin., 1924, xx, 1505.
33. ROSENBURG, A. Ueber menstruelle durch das Corpus luteum bedingte Mammaveraenderungen. Frankfurt. Ztschr. f. Path., 1922, xxvii, 466–506.
34. ROSENTHAL. Ueber Neuralgieen der Mamma und neuralgische Brustdruesenknoten. Wien. med. Presse, 1873, xiv, 25–28.
35. RUFZ, E. Affection douloureuse des glandes mammaires. Arch. gén. de méd., 1843, iii, 73–85.
36. SAMUEL, M. Ueber Mastodynie. Deutsche med. Wchnschr., 1909, xxxv, 1270–1271.
37. Idem. Ueber die Sekretion der weiblichen Brust infolge ihrer sexuellen Erregbarkeit. Ztschr. f. Sexualwissensch., 1926–1927, xiii, 186.
38. Idem. Die Mastodynie. Zentralbl. f. Gynaek., 1928, lii, 1267–1268.
39. SCHWEITZER, B. Zu den Wechselbeziehungen zwischen Genital- und Mammafunktion. Zentralbl. f. Gynaek., 1923, xlvii, 717–720.
40. SEBENING, W. Zur Physiologie und Pathologie der Brustdruese (Die menstruellen Veraenderungen der weiblichen Brustdruese—Das Krankheitsbild der schmerzhaften Knoetchenbildung—Mastitis chronica cystica). Arch. f. klin. Chir., 1925, cxxxiv, 464–485.
41. SNOW, H. The "dispersible" tumors of the female breast: with cases. Am. J. M. Sc., 1895, cix, 235–239.
42. SOJO CARMONA, J. M. Sein douloureux. Paris thesis, 1887.
43. TERRILLON. Des neuralgies du sein. Progrès méd., 1886, xiv, 187–190.
44. VALLEIX, F. L. I. (See Rufz, loc. cit.) Arch. gén. de méd., 1843, iii, 85–88.
45. VELPEAU, A. A. L. M. Traité des maladies du sein et de la région mammaire. p. 258. Paris: Masson, 1854.
46. Idem. A treatise on the diseases of the breast and mammary region, Translated by Mitchell Henry. London: Sydenham Soc., 1856.
47. VIGNARD. Un cas de mastodynie. Gaz. méd de Nantes, 1904, xxii, 449–452.
48. VINEBERG, H. N. What is the fate of the ovaries left *in situ* after hysterectomy? Tr. Am. Gynec. Soc., 1915, xl, 59–80.
49. WESTMAN, A. Untersuchungen ueber die Ovarialfunktion nach Uterusexstirpation. Zentralbl. f. Gynaek., 1929, liii, 2578–2582.
50. WEWER. Ein Fall von Mastodynie auf hysterischer Basis. Frauenarzt, 1887, ii, 315–318.
51. WITTHAUER, K. Ueber Neuralgia Mammae. Beitr. z. Geburtsh. u. Gynaek. (Festschr. f. Heinrich Fritsch), 1902, 42–50.
52. ZIMMERMANN, R. Hat der Uterus innersekretorische Bedeutung? Arch. f. Gynaek., 1928, cxxxiv, 328–349.

CHRONIC CICATRIZING ENTERITIS

Regional Ileitis (Crohn). A New Surgical Entity[1]

FRANKLIN I. HARRIS, M.D., F.A.C.S., GLENN H. BELL, M.D., HAROLD BRUNN, M.D., F.A.C.S.,
San Francisco, California
From the Surgical Services of the Mount Zion Hospital and the University of California Hospital of San Francisco

"NON-SPECIFIC granuloma," "infectious granuloma," and "benign granuloma of the intestine" as used in the American surgical literature and "intestinal phlegmon, or inflammatory tumor of the intestine" as used in European literature bring to the mind and memory of the surgeon the recollection of the occasional case of an intestinal tumor encountered in his practice that defied classification. It was neither neoplastic nor of specific bacterial origin and its etiology, pathology, treatment, and prognosis have been the source of much conjecture and concern.

Study of the surgical literature, in particular that literature devoted to clinical reports and surgical society discussions, reveals an unusually large interest in discussions of this type of tumor which at the operating table so closely simulates malignancy, but is ultimately proved to be of an inflammatory nature. Such tumor-like processes are reported as being found in any part of both the small and large intestines. They are recognized as not being carcinoma, lymphosarcoma, tuberculosis, Hodgkin's disease, or diverticulitis and the multiplicity of the various sites in which they occur with the varying clinical manifestations has to date produced a confusion which has prevented any proper clear cut description of these lesions.

From this confusion of ideas concerning rare benign intestinal lesions, Crohn, Ginzburg, and Oppenheimer have separated a group which appears to answer all the requirements of a specific clinical entity with well defined pathology and clinical characteristics to which they have proposed the name "regional ileitis."

Regional ileitis as defined briefly by these writers is a disease of the terminal ileum, affecting mainly young adults and characterized by a subacute or chronic necrotizing and cicatrizing inflammation of all the coats of the ileum which frequently leads to stenosis of the lumen and is often associated with fistula formation and a tumor mass in the right lower quadrant.

PATHOLOGY

The disease apparently in its earlier stages is confined to the mucosa of the small intestine, most frequently in the region of the terminal ileum. There are present small oval areas of ulcerations located on the mesenteric border of the small bowel mucosa. The submucosa and to a lesser extent the muscular layers of the bowel show marked inflammatory hyperplastic and exudative changes producing an enormous thickening of the bowel wall to two or three times its size (Figs. 1, 2, 3, and 4). This thickening of the bowel wall encroaches on the lumen of the gut producing varying degrees of stenosis so that the intestine proximal to the involved segment may become greatly dilated. There may be alternating areas of constriction and dilatation (Fig. 5).

The mesentery of the affected segment is thickened and fibrotic and contains numerous hyperplastic lymph glands (Fig. 6). Later in the disease process the exudate reaction is replaced by a marked fibrosis. There is seen a remarkable extensive fibrosis extending into the mesentery of the involved segment of bowel. A fibrotic stenosis occurs in the bowel itself.

When the terminal ileum is involved the most intense inflammatory reaction is located in the region of the ileocæcal valve and the most advanced pathological changes are present in Bauhin's valve which may become converted into a rigid diaphragm with a small opening. This stenotic ileocæcal junction (Fig. 7), with its adjacent hyperplastic

[1] Read before the Pacific Coast Surgical Association, February 25, 1933.

terminal ileum constitutes the mass which is so frequently found clinically in the examination of the right lower quadrant.

Crohn, Ginzburg, and Oppenheimer call attention to the marked tendency to slow perforation of the bowel. This perforating process is so chronic that walling off by adhesions to an adjacent viscus or to the omentum and parietal peritoneum is the usual thing. The walled off abscesses resulting from such chronic perforations are often mistaken for appendicular abscesses. Drainage of such an abscess gives rise to a chronic fæcal fistula which defies closure because of persistence of the underlying inflammatory disease in the bowel (Case 1).

Microscopically there are no distinctive features, sections show various degrees of acute, subacute, and chronic inflammation. In some cases giant cells are found which are probably the result of a foreign body type of reaction. Otherwise there is no evidence whatsoever to suggest tuberculosis (Figs. 2, 3, 4, and 6).

CLINICAL ASPECTS

Clinically Crohn and his associates distinguish four types of this disease: (1) acute—showing signs of intra-abdominal inflammation; (2) symptoms of ulcerative enteritis; (3) stenotic phase with symptoms of chronic obstruction of the small intestine; (4) fistulous stage with persistent and intractable fistulæ in right lower quadrant.

Type 1. Signs of acute intra-abdominal inflammation. Before operation these cases are almost impossible to distinguish from acute appendicitis. Colic-like pain and tenderness in the right lower quadrant with fever to 101–102 degrees and moderate leucocytosis are present. The onset of symptoms, however, appears to be more gradual than in appendicitis. A mass in the right lower quadrant may be present even without abscess formation. At operation there is found a greatly thickened, red, blotchy terminal ileum with marked œdema of the surrounding tissues and slight exudate of the ileal wall. The mesentery is thickened and œdematous and contains numerous large glands. Clear fluid is present in the abdomen. An abscess may be encountered which is seen not to be of appendiceal origin, but because of the contiguous inflammation the appendix may show some involvement of its serosa and the pathologist may report "subacute appendicitis" on the removed appendix. The appendix, however, is not related etiologically to this disease. The surgeon is puzzled at the picture he finds and at this time usually considers the diagnosis of ileocæcal tuberculosis or lymphosarcoma. The following case history illustrates this stage of the disease.

CASE 1. L. G., white, female, single, aged 19 years. Past history and family history are unimportant. The present illness started about the first of December, 1931, when she began to suffer from vague abdominal symptoms which were characterized by dull epigastric pain with an occasional attack of loose watery stools from three to five a day. These attacks at this time were attributed to intestinal influenza. There was no nausea or vomiting. The attacks continued throughout the month of December with remissions of a few days at a time until December 29, 1931, when the patient complained of marked weakness. Dr. Firestone was called in and found the patient had a temperature of 101 degrees. Because of her complaint of pain in the right lower quadrant he diagnosed her condition as acute appendicitis and sent her into Mount Zion Hospital. Physical examination showed a moderately obese young woman who stated that she had lost about 8 pounds during the last month. The examination otherwise was negative except for the abdominal examination.

The abdomen showed moderate distention. On palpation there was a definite rigidity over the right lower rectus muscle with marked point tenderness over McBurney's point. There seemed to be an indefinite mass in the right lower quadrant. Leucocyte count was 12,200, polymorphonuclears, 78 per cent. Temperature was 100 degrees. With these findings a diagnosis of probable appendiceal abscess was made and the patient was taken to surgery.

December 30, 1931, at operation which was performed through a McBurney muscle splitting incision, there was found a considerable amount of free fluid. Exploration of the right lower quadrant of the abdomen showed the presence of a hard mass apparently involving the cæcum and terminal ileum. The appendix was located with difficulty and found to be small, atrophic, not particularly inflamed and it was quite apparent that it did not account for the clinical picture and findings; it was removed. Further exploration showed that the terminal ileum was greatly thickened, the serosa reddened and blotchy with a fibrinous exudate covering it. There was general œdema of the surrounding tissues and the mesentery of the terminal ileum was œdematous, contained numerous hyperplastic lymph glands. The entire mass of terminal ileum, cæcum, and

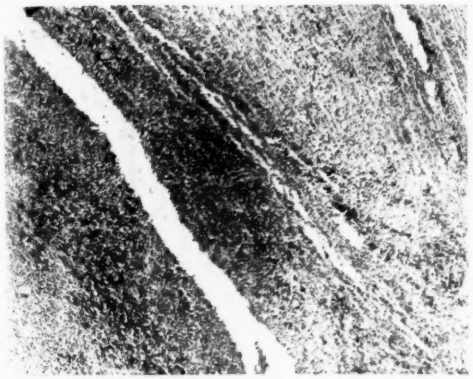


Fig. 1. Case 3. Photomicrograph showing the ulceration of the mucosa and infiltration of the submucosa.

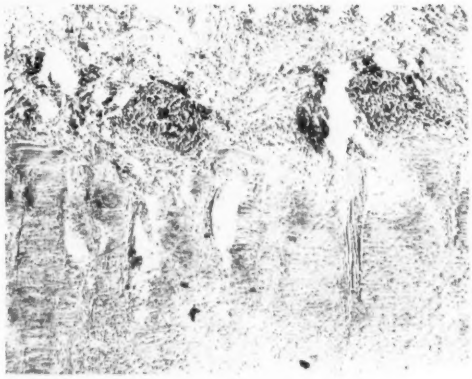


Fig. 2. Case 2. Photomicrograph showing the marked chronic reaction in the submucosa.

ascending colon was fixed and was matted together by fine fibrinous adhesions. During this exploration there was a gush of pus which seemed to come from an abscess located in the wall of the cæcum at the junction of the cæcum with the ileum. Drains were placed down to this abscess and the abdomen closed. The postoperative diagnoses were: (1) tuberculosis of the bowel; (2) probable malignancy; (3) subacute inflammatory cellulitis of the terminal ileum and cæcum of unknown origin.

The pathologist's report on the removed appendix was that of subacute appendicitis, due to the fact that there was an inflammatory reaction in the serosa and muscular layer. The mucosa of the appendix, however, was quite free of inflammation.

The patient had a stormy postoperative course which was characterized by symptoms of partial bowel obstruction. She became markedly distended and on frequent occasions considerable difficulty was encountered in relieving this postoperative distention. The drainage from the wound was moderate and the temperature ranged between 100 and 101 degrees for about 10 days after operation. On February 21, 1932, however, the clinical picture had improved, the wound had completely healed, and she was able to leave the hospital. At this time X-rays were taken which showed a chronic obstruction of the ileum in the region of the cæcum (Fig. 8). The nature of the disease process, however, was still a mystery, and it was decided to observe the patient further. The details of the follow-up and subsequent course of this patient will be given later in the paper.

Type 2. Symptoms of ulcerative enteritis. There is a history of diarrhœa associated with colic-like peri-umbilical pain and lower abdominal pain related to defæcation, there being three to five liquid stools a day which may contain pus, mucus, or visible blood. A constant low grade fever is present and with

Fig. 3. Case 2. Photomicrograph showing the inflammatory reaction in the serosa.

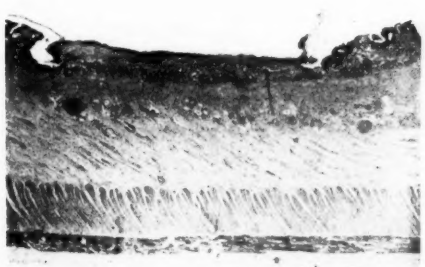


Fig. 4. Case 1. Photomicrograph of the wall of the bowel showing the chronic reaction in the submucosa.

Fig. 5. Case 3. Photograph showing the areas of dilatation and constriction.

the progress of the disease there is marked loss of weight and a pronounced secondary anæmia. The course may continue for as long as a year with increasing exhaustion or more frequently the case passes gradually into the stenotic phase of the disease.

CASE 2. E. M., school girl, aged 18 years, single. This patient entered the Children's Hospital under the care of Dr. W. H. Bender. One of us saw her in consultation and later operated upon her. She complained of lower abdominal cramps, nausea, and vomiting. Her family history and past history were essentially negative. Patient had always been well without any abdominal symptoms until September, 1931, when without any apparent cause she began to notice lower abdominal cramps with four or five loose bowel movements daily. Bowel movements were foul but never bloody. Symptoms continued with varying degrees of severity but the patient was able to continue her school work. She was seen by her family doctor who made a diagnosis of chronic appendicitis. He advised operation which, however, was declined.

In February, 1932, as her symptoms were still present she consulted another doctor who subjected her to a complete examination including X-rays and laboratory examinations of stools, etc., and made a diagnosis of colitis. She was treated medically and improved somewhat but after a few months the symptoms became more marked and the patient stated that with her attacks of abdominal cramps she noticed wave like movements over her lower abdomen which was probably due to visible peristalsis. During this period of time she gradually lost weight. Her weight at onset of illness was approximately 130 pounds and on admission to the hospital in August, 1932, about 1 year after the onset of her symptoms, she weighed 100 pounds.

Physical examination was essentially negative except for the fact that the patient had lost considerable weight and her temperature was 100.6 degrees. Examination of the abdomen, however, showed a smooth, oblong mass, palpable in the right lower quadrant which was thought to be cæcum. There could be seen visible peristalsis during the attack of cramps that the patient complained of. Her hæmoglobin was 80 per cent; red blood cells 4,500,000; white blood cells 8,000 with 74 per cent polymorphonuclears. This high count was probably due to dehydration.

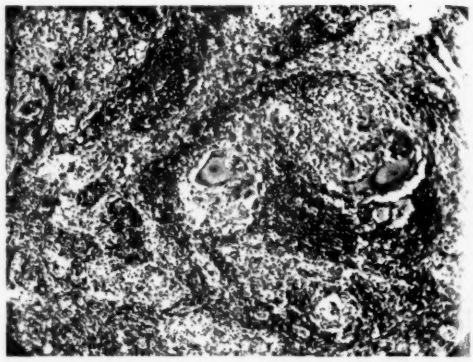


Fig. 6. Case 3. Photomicrograph of a lymph node showing endothelial hyperplasia and foreign body giant c reaction.

Course in hospital. The patient was put on medic regimen. Every type of laboratory investigation wa carried out. She continued to lose weight and ha persistent abdominal cramps with nausea, vomiting and diarrhœa. Her weight went down to 91 pound over a period of 17 days that she was under observation in the hospital.

Check up gastro-intestinal series taken on August 25, 1932, with serial films taken 3, 6, 9, 12, and 2 hours after the administration of barium by mouth showed definite small bowel obstruction probably i the terminal ileum (Fig. 9). Operation was advised.

Operation was performed by Dr. Harold Brunn on August 27, 1932, following transfusion of 500 cubic centimeters of blood. When the abdomen wa opened there was found a hard, annular constriction of the lower ileum about one foot above the ileocæcal valve and involving the ileum for about 6 inches (Fig. 10). The corresponding segment of the mesentery was markedly thickened and œdematous (Fig. 11). It was superficially inflamed, and there were flecks of fibrin in the peritoneal covering on this part of the bowel. The adjacent mesenteric glands were moderately enlarged. The cæcum was found to be essentially normal. A resection of the pathological area of the lower ileum was performed with end-to-end anastomosis. The patient expired on the fourth day after operation. Postmortem examination was refused.

This case illustrates the type that goes on for a period of many months, is treated medically with a diagnosis of some type of enteritis or colitis, and ultimately comes to operation because of the development of symptoms of a partial obstruction of the small bowel.

Type 3. Stenotic phase. In Crohn's experience this is the type most commonly found

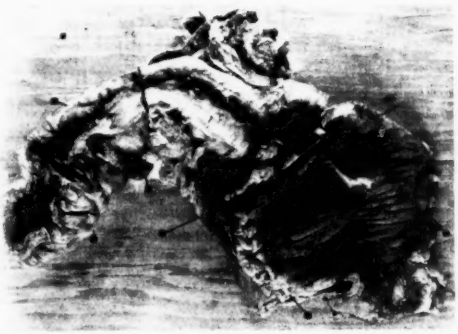


Fig. 7. Case 1. Photograph of the gross specimen, showing the dilatation and constriction.

The symptoms are now those of a partial obstruction of the small intestine. Violent cramps with attacks of vomiting and constipation are present, visible peristalsis and distention are common, a palpable mass is usually present in the right lower quadrant.

The stenotic phase may occasionally occur as the first manifestation of this disease although minor symptoms may have been present for years.

Case 3. A. H., male, white, 24 years of age, married, entered the University of California Hospital, December 13, 1932. He complained of cramp-like pain in the upper abdomen. The past history was essentially negative except for the fact that at the age of 11 years he began to have abdominal symptoms of nausea without vomiting, loss of weight and anæmia which lasted for 3½ years. At that time he was studied in the Mount Sinai Hospital, New York City, and was finally discharged without a diagnosis. After 3½ years, his abdominal symptoms disappeared without having followed any particular regimen and he was in fairly good condition up to the onset of present illness, except that he was always rather thin and anæmic in appearance. The present illness started in July, 1932, when he noticed transient attacks of abdominal cramps with nausea and vomiting. At the onset of these symptoms in July he was studied at the University of California Hospital and was finally discharged with a diagnosis of pylorospasm, etiology undetermined.

On December 13, 1932, he re-entered the hospital with the same complaint of abdominal cramps, nausea and vomiting, but he had in addition lost 20 pounds during the preceding 5 months and his symptoms were now so severe that he was totally incapacitated. The patient, who was a medical student, stated that he had noted recently when attacks of cramps came on that he could see isolated dilated loops of bowel through his abdominal wall.

Fig. 8. Case 1. Roentgenogram showing dilatation of the ileum and a narrow tract extending into the cæcum.

Physical examination was negative except for loss of weight and abdominal findings. The abdomen was thin with slight fullness in upper right quadrant. Visible peristalsis could be seen at times. On palpation an indefinite mass just to the right of and just above the umbilicus was felt which could be moved from side to side. No muscle spasm or rigidity was present. Red blood cells, 5,350,000; hæmoglobin, 104 per cent; white blood cells, 5,750 with 62 per cent of polymorphonuclears. X-ray examination (Dr. Stone) showed partial obstruction of small bowel at lower jejunum or upper ileum (Figs. 12, 13).

Operation. When the abdomen was opened the jejunum was found markedly dilated and hypertrophied measuring 12 centimeters in circumference from Treitz's ligament distally for a distance of 60 centimeters. At this point there was an annular constriction about 4 centimeters long, then a dilated segment 9 centimeters long, following which there were alternating areas of dilatation and constriction for a distance of 60 centimeters (Fig. 5). The mesentery was greatly thickened due to œdema and enlarged lymph glands. There was some free abdominal fluid. There was no evidence of acute inflammatory changes in the bowel wall. Ninety-five centimeters of the diseased bowel was resected and a side-to-side anastomosis performed. Patient did well for about 36 hours and then expired suddenly. No postmortem examination was made. This case is illustrative of the type in which the stenotic phase of the disease is its first manifestation.

Fig. 9. Case 2. Dilatation of the ileum.

Type 4. Fistulous stage. Fistula formation is fairly constant in this disease. More commonly the connection is with the sigmoid, next in frequency the cæcum and ascending colon, and even the transverse colon. Practically diagnostic of the disease is a fistula in the abdominal wall persisting and appearing after operation for a supposed acute appendicitis and the removal of an innocent appendix. These fistulæ seem to connect with the cæcum, but are in reality communications between the necrotic terminal ileum and the anterior abdominal wall. They differ from simple appendiceal fistulæ in that they never close spontaneously, resist simple surgical closure by excision and inversion of the stump and, as already stated, connect with the terminal ileum rather than the cæcum.

Another peculiar feature of these fistulæ is that they may develop months after the original drainage operation for a supposed appendiceal abscess. The original wound meanwhile has completely healed and the first sign of the fistula formation is the appearance of an abscess in the wall which, on being opened, is found to lead to the intestines.

CASE 1. (Part 2.) L. G., white, aged 19 years, single. This patient was operated upon on December 30, 1931 for acute appendicitis with the findings as described in the preceding part of this paper under Case 1.

She re-entered the Mount Zion Hospital on Jun 23, 1932, stating that she had remained quite we following her discharge from the hospital in th early part of February for a period of about month. She then noticed an abscess formation i her wound and consulted Dr. Franklin I. Harris wh on opening the abscess discovered that it led to fistulous tract which appeared to connect with th intestine. This fistulous tract was treated co servatively and at times appeared to close, but wh this happened the patient developed symptoms partial bowel obstruction which were not relieve until the fistulous tract opened up.

General physical examination was essential negative except for the abdominal examinatio Examination of the abdomen showed an irregul McBurney's scar in the right lower abdomen at th distal end of which there was a discharging sin from which at times gas and liquid fæces appeare There could also be palpated a small indefinite ma in the right lower quadrant. X-ray examination f this patient, as previously reported, showed chronic obstruction of the ileum at the region of th cæcum. Injection of the fistula with lipiodol showe it to lead apparently to the ileocæcal region. It could not be definitely demonstrated at this time whether it connected with the terminal ileum or th cæcum. It was decided to re-operate upon this patient in order to close the fistula and to explore the cause of the partial bowel obstruction found in the earlier X-ray examination (Fig. 8).

Operation was performed on June 27, 1932, by Dr. Franklin I. Harris. An incision was made en circling the fistulous tract, which was carefully dissected down and found to lead apparently to the junction of the terminal ileum to the cæcum. At this time it was thought that it led to the cæcum, but we now know that it led to the terminal ileum. Further examination of the ileocæcal region showed that the tremendous inflammatory reaction noted in the preceding operation in December had subsided considerably. There was now seen and felt a nodular mass in the ileocæcal junction. The terminal ileum was thickened and the transverse colon which was adherent at this point was carefully dissected free and there was found an imperforate fistulous connection between the transverse colon and the terminal ileum and cæcum. This opening in the transverse colon was closed and this part of the bowel separated from the ileocæcal mass. Because of the findings of definite obstruction in the ileocæcal region with fistulous tract leading to it, it was decided to resect the terminal ileum with the cæcum and part of the ascending colon. About 4 inches of the terminal ileum was removed with the cæcum, the adjacent fistulous tract, and part of the ascending colon (Fig. 7). A side-to-side anastomosis was performed between the distal end of the ileum and

Fig. 10. Case 2. Showing the lower end of the ileum. Proximal segment dilated. The narrowing of the lumen and thickness of the wall is very well shown.

Fig. 11. Case 2. Reverse side of Figure 10 showing the thickness of the mesentery which gave the impression of a tumor formation.

the transverse colon. The patient made an uneventful recovery and at the present writing is enjoying excellent health without any abdominal symptoms whatsoever.

This patient illustrates two phases of the disease, her first attack simulating the phase in which the disease is mistaken for acute appendicitis, the second stage illustrates the fistula formation so commonly found in this disease process. One incomplete fistula led to the transverse colon, the other to the anterior abdominal wall.

DISCUSSION OF NOMENCLATURE

There seems to be little doubt that Crohn, Ginzburg, and Oppenheimer have brilliantly isolated from the existing confusion of benign inflammatory intestinal lesions a new disease entity. Clinically the disease occurs mainly in young adults with symptoms resembling those of ulcerative colitis; namely, fever, diarrhœa, and emaciation. They are often mistakenly operated on for acute appendicitis. The disease process eventually leads to an obstruction of the small intestine with characteristic obstructive symptoms. The outstanding physical findings in this disease are a tumor mass over the site of the lesion and the common formation of fistulæ. The etiology is unknown. The microscopic and macroscopic pathology are constant and characteristic. It is a benign disease and according to the investigations of Crohn involves only the terminal ileum.

We question, however, their limitation of this disease process to the terminal ileum. One of our cases, and another case we are not reporting in this paper, clinically and microscopically showed the characteristic lesions described by Crohn and associates, and involved mainly the jejunum. It is our belief that with more universal recognition by surgeons of this disease process other cases will be reported involving the jejunum as well as the terminal ileum. For this reason the name regional ileitis deserves some discussion as to its fitness. It seems to us that until such time as its etiology is determined a more descriptive term is advisable based on the pathological process and should include also the idea that any part of the small intestines may be affected. With this thought we are offering the term "chronic cicatrizing enteritis."

RADIOGRAPHY

The disease is commonly overlooked by competent roentgenologists unless the clinician suggests it and demands serial fluoroscopic examinations of the barium meal. Such examinations may show delay in the small bowel early in the disease and later in the stenotic phase definite evidence of obstruction with dilatation of small bowel loops.

When the disease simulates ulcerative colitis a barium enema is usually attempted and as would be expected is reported as negative. Such a negative finding with clinical features suggestive of colitis and enteritis should make

Fig. 12. Case 3. Roentgenogram showing the dilatation of the small bowel (jejunum) extending across the abdomen.

Fig. 13. Case 3. Roentgenogram showing the dilated small bowel and a pocket of barium such as is seen in a diverticulum.

the clinician insistent on a careful serial roentgenological examination with a barium meal.

DIFFERENTIAL DIAGNOSES

The lesion must be differentiated from other well recognized conditions which produce a mass in the right lower quadrant with diarrhœa and fever. Under this category are listed: non-specific ulcerative colitis, ileocæcal tuberculosis, mesenteric tuberculosis, Hodgkin's disease, lymphosarcoma, and more rarely actinomycosis.

TREATMENT

Medical treatment is symptomatic and supportive. A complete cure must depend on the surgical resection of the diseased bowel. In cases in which this has been done successfully the patient has been restored to complete health. Such a case may require multiple stage operations. In the light of our experience a preliminary short circuiting operation such as ileocolostomy with a later resection of the diseased bowel when the patient has been built up would seem to be the better surgical judgment.

Simple ileocolostomy without the removal either at the original operation or later of the diseased obstructed bowel carries with it the added danger of the obstructed bowel becoming dilated and ulcerated. The recent work of Holm has definitely shown both experimentally and clinically that the side-tracked bowel in short circuiting operations is a constant menace to the health of the patient. A. A. Berg of New York who has had the greatest experience in the surgical treatment of cases of regional ileitis advocates resection with ileocolostomy as the operation of choice.

SUMMARY

1. Crohn, Oppenheimer, and Ginzburg have described a surgical disease which they call "regional ileitis." This disease has we

defined clinical and pathological characteristics and its description will be found to cover many of the heretofore unclassified inflammatory tumors and lesions of the small bowel.

2. We are reporting 3 cases of the disease, in 1 of which the jejunum was found to be mainly involved.

3. The name of "chronic cicatrizing enteritis" is suggested as a more descriptive and inclusive term for this new surgical entity.

REFERENCES

1. Crohn, Burril B., Ginzburg, Leon, Oppenheimer, J. Am. M. Ass., 1932, xcix, No. 16.
2. Holm, C. E. Surg. Gynec. & Obst., 1933, lvi, 746.

CLINICAL SURGERY

FROM THE DEPARTMENT OF SURGERY, WASHINGTON UNIVERSITY

THE CORRECTION OF SCROTAL HYPOSPADIAS AND OF EPISPADIAS

VILRAY P. BLAIR, M.D., F.A.C.S., JAMES BARRETT BROWN, M.D., F.A.C.S.,
WILLIAM G. HAMM, M.D., F.A.C.S., ST. LOUIS, MISSOURI

TO be really useful any plan for the operative correction of either hypospadias or epispadias must fulfill four requirements:

1. It must utilize tissues of approximately the same bulk and elasticity as are the normal structures it restores.

2. The plan of using these must be inclusive,[1] exact, and surgically correct.

3. It must relieve the chordee, or the reverse, that usually complicates one of these conditions.

4. It must reproduce a functional urethra.

Partly from our own blunders and largely from re-operation in patients who had been previously worked upon, we have formed the opinion that no tissue will make a satisfactory restoration except that which comes from the penis or scrotum. Most others are too bulky and all, including free skin grafts, lack elasticity.

In practically all cases having well developed testicles there is originally enough spare scrotal covering to make a generous functional restoration, provided it is properly used. Too often the repair is complicated by loss of tissue from previous operative attempts or from incisions made across the direction of the blood supply.

HYPOSPADIAS

At first thought a functional urethra might seem to be the most important objective, but this is not so. In childhood the urethra is of primary interest, but, after man's estate has been attained, a restoration that has failed to correct the chordee, which seems to be essential to complete hypospadias, is not apt to be acceptable. Men who have been given functional urethras continue to present themselves for re-operation on this account.

In the following illustrations, which are selected from sketches made at the operating table, and in the legends which accompany them, an attempt is made to illustrate plans of treatment for both hypospadias and epispadias which, for us, have reduced the average number of steps and have eliminated much uncertainty from the immediate and ultimate results.

The one essential difference between these and the plan we hesitated to publish a quarter of a century ago is that now we use a broad, short covering flap in place of the long narrow one with which at that time we sought to avoid the uncertainty essential to the attempt to both line and cover the new urethral section from flaps taken entirely from the penis. An attempt to restore the urethra before the age of 5 years may not be advisable, but straightening the ventral concavity can usually be done at the age of a year or two, while by choice the whole correction should be completed before puberty.

In a popular system of surgery in the article on hypospadias it states: "in any case the results are obtained with difficulty. In the scrotal varieties surgical treatment can accomplish nothing." At the time this appeared we had successfully treated several cases of the latter type, and, after reading the statement quoted, drawings were made preparatory to publication of the plan. However, the loss of the covering flap in a subsequent case demonstrated the need of further study, and it was a number of years before we again felt sufficiently sure of the plan to warrant its presentation. Among other experimental plans, in one case, a free transplantation was made of a section from the muscular layer and mucosa of the patient's own appendix which plan, at the time, was being considerably discussed. The tube remained patent, but we removed it some months later because its length had shrunken badly which entirely negated its usefulness. The man had previously been given a functional urethra but came to us for relief of the chordee.

The attempt noted was prompted by a report from Dr. Stewart McGuire of a successful homo-appendix transplant in a young boy which, according to the information he subsequently received, had continued to function for the missing section of the urethra.

In laboratory experiments of our own, in the reported experiments of others, or in any actual clinical report of patient the survival of epithelium has not been demonstrated microscopically where a graft of intestinal mucosa has been implanted into or under the surface.

[1] "Inclusive" plan refers to correlation of the separate steps, while exactitude conserves tissue and enhances the quality of the result. The plan will be surgically correct when the right tissues are so patterned, placed, and subsequently cared for as to insure circulation, promote union, and give the best possible ultimate function.

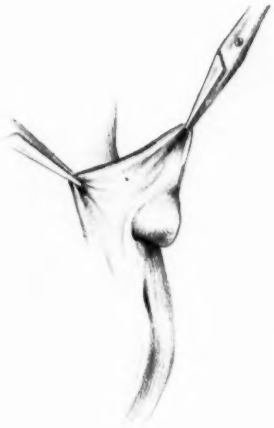


Fig. 1.

Fig. 2.

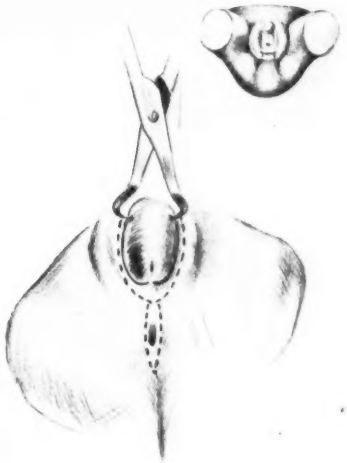


Fig. 3

Fig. 1. Uncomplicated scrotal hypospadias. Drawing made at the age of 10½ years immediately after breaking up the coronal adhesions, showing the more characteristic appearance of a scrotal hypospadias not operated upon. Note the wealth of movable penile skin on the dorsum and sides which is available for the repair flaps. The shaded spot on the scrotum indicates the position of the urethral opening.

Fig. 2. Uncomplicated scrotal hypospadias. Traction on the glans better demonstrates that this redundant skin covering envelops the dorsum and sides of the organ like a loosely draped cloak, with a high roll collar covering the corona, but that along the ventral surface it is closely fixed to an underlying non-elastic band of fibrous tissue that draws the scrotal opening of the urethra forward, and the glans backward. The deep surface of this fibrous band is so closely adherent to the underlying corpora cavernosa that it prevents elongation of this surface of contact. In erection this acts somewhat as a taut bow string, causing the chordee referred to in the text (see also Figs. 1 and 3).

Fig. 3. Uncomplicated scrotal hypospadias—first operative step. This figure and Figure 4 show another instance in a 14 year old child, in whom the general formation of the external genitals is of a still more primitive type than that illustrated in Figure 1. Besides the scrotal hypospadias, which is a characteristic of the female pattern, the two halves of the scrotum here meet above, envelop the base of the penis, very much as do the labioscrotal folds in the 4 week embryo. (Keibel's reconstruction of human external genitals of 33 day old embryo[1].) See insert on Figure 3. All of the urethra anterior to the scrotum is congenitally absent, but in the development the scrotal urethra has been drawn forward and the glans backward until they are separated by the short connecting fibrous band.

[1]Piersol's *Human Anatomy.*

The first objective of an operation that seeks to build up an approximately normal condition should be to liberate the ventral surface of the corpora cavernosa by dissecting off all of this band, and also freeing that part of the urethra which has been displaced forward. This will bare the whole of the under surface of the essential sheath of the cavernosa in its pendulous portion and demonstrate the full extent of the urethral defect. Occasionally a narrow tract will be found in this fibrous tissue that, in direction and location, simulates the missing urethral section. This we remove with the fibrous tissue because an attempt to utilize it would defeat one of the essential objectives of the operation.

This new increase in the distance between the urethral opening and the glans is made permanent by transfer to the ventral surface of sufficient elastic penile covering to permit of full elongation when the cavernosa are engorged. It is from this transferred skin that the lining of the new urethral section will ultimately be made. In a previously unoperated upon case this can be obtained by continuing the coronal incision completely around the dorsum just slightly proximal of the line where the prepuce is attached, making a dorsal slit as shown in Figure 4. These incisions are made to, and the undermining is done in, the areolar tissue plane that permits the free movement of the skin covering. The double fold of skin forming the prepuce may contain some fibrous bands, the cutting of which may be necessary before it can be entirely flattened out into a flap. If the meatus is to be placed at the frenum, the length of the dorsal incision will be a little more than one-half the diameter, but, if the meatus is to be at the tip of the glans, then the length of the dorsal slit must be increased by the length of the glans. It is well to decide upon the location of the meatus after these flaps have been freed and the blood supply has been demonstrated.

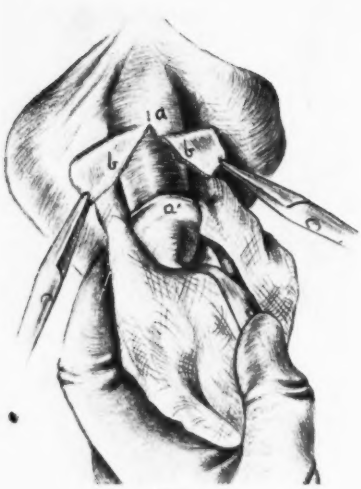


Fig. 4.

Fig. 5.

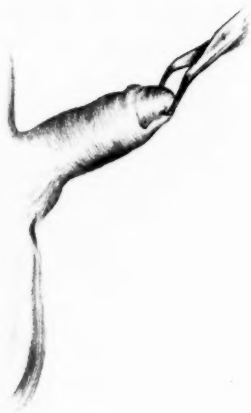


Fig. 6.

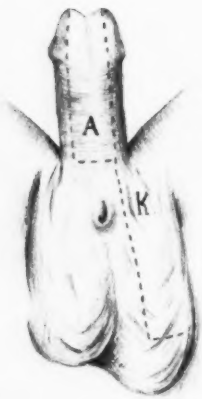


Fig. 7.

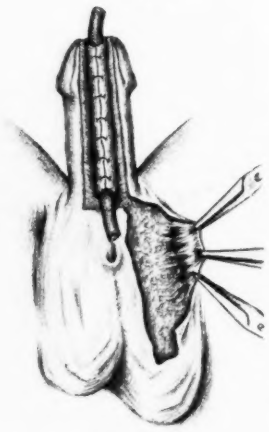


Fig. 8.

Fig. 9.

Fig. 10.

Fig. 4. Uncomplicated scrotal hypospadias—first operative step. The condition after removal of fibrous tissue from the ventral surface, completion of the coronal incision and dorsal split, and the flaps freed ready to suture. The first step in suturing is to unite *a* to *a* and the free borders *a*—*b* and *a*—*b* along the skin incision surrounding the corona. The distal parts of flaps may line glans part of new urethra.

Fig. 5. Uncomplicated scrotal hypospadias—first operative step completed. Shows the scrotal meatus moved back into its correct location, and the whole of the under surface of the body covered and the cut in the glans lined with skin shifted from the sides and dorsum. If, from lack of available prepucial skin, naturally or from previous operations, it seems impractical to restore the urethra beyond the frenum, a functional result can be obtained by placing the new meatus at this level, and the operation will become quite a bit simpler as will be seen from Figures 13 and 14.

Fig. 6. Uncomplicated scrotal hypospadias. Compare Figures 1 and 2 to see the lengthening of the body, the more backward position of the original meatus and the more normal contour that has resulted from the preceding steps.

Fig. 11.

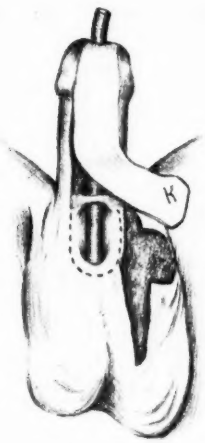


Fig. 12.

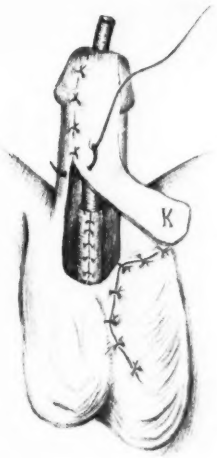


Fig. 13.

Fig. 7. Uncomplicated scrotal hypospadias—second operative step. Same case, 10 months later, when the second operative step was undertaken to construct the pendulous part of the urethra. The lining of the new urethral section is to be made from the previously transplanted penile skin, the resulting raw areas covered by a wide short scrotal flap. The incisions are shown by the dotted lines. The width of the outlined skin strip *A* equals one and one-half times the circumference of the desired lumen of the tube and its posterior extremity corresponds to the site of the normal bend of the flaccid organ. We have found it a mistake to attempt to reconstruct the urethra farther back at this time. The *K* flap is made amply long and wide to cover the *A* area. The base of this *K* flap is very broad and is toward the blood supply which comes in laterally.

Fig. 8. Uncomplicated scrotal hypospadias—second operative step. The *A* flap has been partially freed along each longitudinal incision but sufficient central attachment is left to insure blood supply. The flap itself is made into a tube by interrupted No. 000 40 day chromic catgut, the free ends of each knot being left to protrude anteriorly alongside of the piece of contained catheter. To simplify the drawing these protruding ends are not shown. The scrotal flap *K* has been raised ready to apply to the raw surface when the body is flexed and rotated to secure contact.

Fig. 9. Uncomplicated scrotal hypospadias—second step continued. The body is bent down and partially rotated to get this contact. Part of one row of interrupted chromic gut sutures is seen protruding along the base, the loops of which engage the right border of the defect, while a second row of sutures, catgut, or horsehair, is uniting the free margin of the scrotal flap to the left border of the defect. Note that this flap is cut quite a bit longer than is apparently needed, and that its distal end is folded so that the new meatus will be bordered by a rolled edge and not a scar line. A few interrupted horsehair or fine chromic gut sutures can be used to bind the center of the flap to the lining (see Figs. 25 and 26, epispadias). One of the very important points here attained is the elimination of superimposed suture lines, which thus gives greater assurance of primary closure. This feature is incorporated in some of the standard techniques but the method is not utilized in others.

Fig. 10. Uncomplicated scrotal hypospadias—second step continued. Final closure of the wound is accomplished by drawing the cut scrotal edge that corresponds to the free end of the *K* flap up to the right border of the defect on the under surface of the penis, that border which was approximated by mattress sutures to the base of the *K* flap (Fig. 9).

Fig. 11. Uncomplicated scrotal hypospadias—third operative step. The result of the previous step and also the incision for freeing the covering flap from the scrotum. This runs along the base of the *K* flap which has now become united to the under surface of the penis. Above it outlines an area which will be raised with and give additional length to this flap.

Fig. 12. Uncomplicated scrotal hypospadias—third step continued. The *K* flap has been cut free from its original attachment and partly mobilized, the resulting raw surface being shown, and also, by dotted line, the plan of completing the urethral lining. For this step a simple drainage catheter is placed and maintained just within the neck of the bladder.

Fig. 13. Uncomplicated scrotal hypospadias—third step continued. The urethral lining has been completed throughout, the scrotal defect has been closed, and the freed part of the *K* flap is about to cover the urethra. If the *K* flap is not long enough entirely to cover the last section of urethra without ventral traction, it can be supplemented by tissue drawn from the scrotum of the opposite side. Usually the skin which furnishes the urethral lining is smooth but an occasional stray hair may be found, on careful examination. It would seem important that the urethral lining be free of hair, but, in operating before puberty, they would likely be overlooked. It is well to make a careful search of the field with a magnifying glass and, when hair is found, each hair bulb is made evident by gentle traction on the hair and the bulb excised through a minute incision. For this procedure and for the cutting and raising of the flaps a knife of razor sharpness is necessary.

Fig. 14.

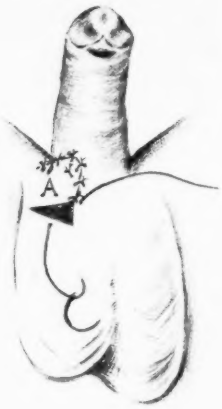


Fig. 15.

Fig. 14. Uncomplicated scrotal hypospadias re-operation. In an otherwise successful case, there may be a leak here or there along the newly constructed urethra, for, if the edge of the lining can in any place heal in continuity with the overlying external skin, either from failure of primary union or from sloughing out of a suture, the fistula will be permanent until closed by an additional operative step. This illustrates such a fistula and the plan of closure. The scar immediately surrounding the opening is to be turned in and approximated with one or two figure-of-eight sutures which will transfix the flap, *A*, after the latter has been mobilized and switched to its new position (see Fig. 15).

Fig. 15. Uncomplicated scrotal hypospadias re-operation. The *A* flap has been shifted to cover the urethral suture line and pierced by one of the urethral figure-of-eight sutures. The suture that is to close the posterior defect is shown in place. This and the previous drawing were made from a case in which the urethra was restored only as far as the frenal attachment.

EPISPADIAS

The chief characteristics of epispadias are a penis very thick and short with a dorsal cleft between the corpora cavernosa that extends into the urethra almost throughout the entire length of the organ. There is little prepuce dorsally, but this deficiency is compensated for by a redundancy of loose covering on the ventral surface. The condition is frequently complicated by some lack of vesicle control which in the cases we have treated was apparently due to traction on the very short urethra; at least control was made much more certain after this traction was released. (When there is an associated exstrophy of the bladder control is of course impossible.)

The objectives of the operation are: (1) To release the tension resulting from the short urethra, the pull of which seems to lessen the effectiveness of a sphincter that is most likely somewhat lacking in strength and also draws the glans against the pubis, (2) to effect closure of the dorsal cleft.

The first objective is accomplished by dissecting the open urethra free from its attachment as far back as the abdominal wall, and then, while the glans is drawn firmly forward and the urethra remains perfectly relaxed, the latter is sutured to the bed as it lies. The plans for obtaining material for piecing out the missing distal part of the urethra and for closing the cleft closely follow those used for hypospadias.

The original appearance, the plan of correction and the result in a typical case are detailed in the following series, which depict the various operative steps in a child of 13 years. In this condition the attempt to make both the lining and covering of the urethra entirely from the bordering penis skin has, in our hands, proved even less certain of result than for hypospadias.

The postoperative dressings and treatment of these are a modification of that described under hypospadias.

In the foregoing we have attempted to illustrate the handling of typical cases of complete scrotal hypospadias or of epispadias in which the patients had not previously been operated upon. Cases of less involvement are treated accordingly. There are possibilities of much grief and disappointment in this work. Operative results may be unsatisfactory either from fault in plan, execution, or healing. In attempting to correct our own and others' mishaps we have had to resort to elaborations or variations of the above plans, but on the average, satisfaction followed only when they were in harmony with the cardinal principles given at the beginning of this paper. Our observations have forced us to the conclusion that some advocated plans are too uncertain of result, and that others will bring disappointment no matter how good the execution or the healing.

DRESSINGS FOR HYPOSPADIAS CASES

The dressing for the first stage operation is done with the penis brought up midline against the abdomen, a gauze flat interposed. This

Fig. 16.

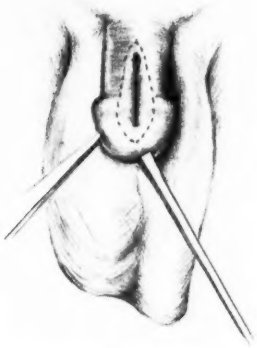


Fig. 17.

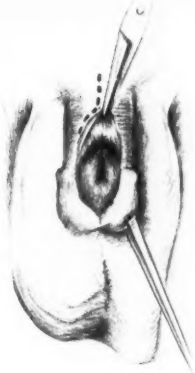


Fig. 18.

Fig. 19.

Fig. 20.

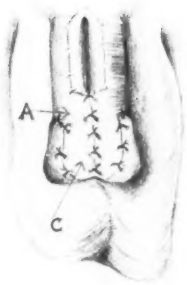


Fig. 21.

Fig. 16. The natural appearance of an uncomplicated epispadias with the prepucial excess of skin draped from the under-surface. Slight rotation of the glans is caused by the traction of the short urethra.

Fig. 17. Uncomplicated epispadias—first operative step. The penis has been drawn out to the fullest extent permitted by the short urethra. The cleft is shown and also the incision for freeing the open part of the urethra from its anterior and lateral attachments.

Fig. 18. Uncomplicated epispadias—first operative step. The beginning of the dissection, which mobilizes the urethra. The detached anterior part of the open urethra is being drawn backward by the forceps.

Fig. 19. Uncomplicated epispadias—first operative step. The transplanted urethra is shown sutured into its permanent position leaving the resulting raw surface of the corpora cavernosa and glans exposed. A cut that has been made deep into the glans for embedding the new section of urethra is also shown.

Fig. 20. Uncomplicated epispadias—first operative step. The spreading part of the two halves of the dorsal portion is shown and the tip of the glans as a result of the median cut mentioned under Figure 19. The coronal and a ventral vertical incision for switching prepucial skin to form the lining of the new urethra are also shown.

Fig. 21. Uncomplicated epispadias—first operative step. The lining of the new section of urethra which is still opened dorsally, has been formed from skin switched from the sides and under surface of the body. Comparing the positions of *A* and *C* as shown in Figures 20 and 21 will give a general idea of just how the new section of urethra was obtained. This completes the first step of the operation. In this condition the new meatus should be placed at the tip of the glans and not at the corona.

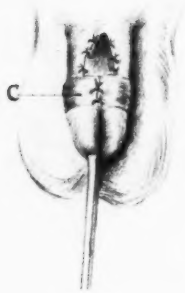


Fig. 22.

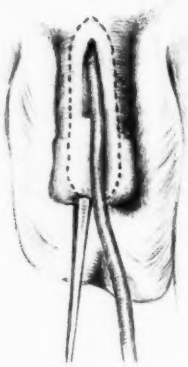


Fig. 23.

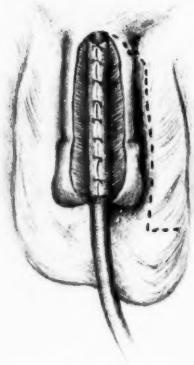


Fig. 24.

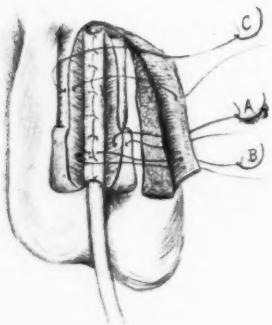


Fig. 25.

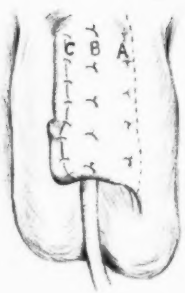


Fig. 26.

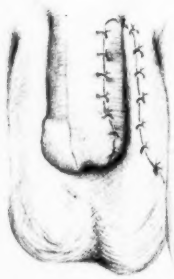


Fig. 27.

Fig. 22. Uncomplicated epispadias—first operative step. This is from a different case in which the dorsal groove extended to the normal position of the meatus at the tip of the glans and was lined throughout with apparently normal urethral mucosa. In this case the urethra was liberated by a transverse incision at the corona. The proximal portion of the urethra was undermined and the prepucial flaps were switched into the resulting defect (see Fig. 20).

Fig. 23. Uncomplicated epispadias—second operative step. The dotted line here indicates the incision which mobilized the borders of the cleft as the first step in closing the urethra.

Fig. 24. Uncomplicated epispadias—second operative step. The lining of the urethra has been sutured over a catheter which rests just within the bladder. The outline of a scrotal covering flap is also shown.

Fig. 25. Uncomplicated epispadias—second operative step. The scrotal covering flap has been dissected free with one suture in each of three rows which will be used to fix it in its new position. *A* is one of a line of interrupted mattress sutures that pierce the base of the flap and will here engage the left border of the defect. *B* represents one of a series that pierce along the central line of the flap and bind it to the suture line of the new urethral lining, while *C* engages the free border of the flap and attaches it to the right border of the defect. The lower free border of the covering flap was turned under to form the dorsal border of the new meatus in such a way that the scar will not be just at the entrance (see Fig. 9).

Fig. 26. Uncomplicated epispadias—second operative step. The flap is shown sutured in place with the position of the *A-B-C* sutures indicated. Naturally these must be sufficiently lax and sufficiently far apart to permit of free circulation within the flap. Any cutting in of a suture in the center row might cause a permanent leak which would require further correction by an extra operative step. This completes the second step of the operation, but on this the indicated the position of the incision which freed this flap from the scrotum in the final step.

Fig. 27. Uncomplicated epispadias—third operative step. The operation completed. The base of the scrotal covering flap has been cut and the raw edges sutured both on the body and on the scrotum.

covered with more saline gauze flats, over which is placed a large, soft, damp marine sponge covered by a pad, the whole being fixed in place by a double spica. The sponge should be at least 6 or 10 inches across, 2 to 3 inches thick, and softly resilient so as to transmit the bandage pressure to the sides as well as to the ventral surface of the penis. As the sponge dries it hardens and, if carefully applied without too much underlying gauze, it will prevent displacement and limit priapism. This bandage should exert just sufficient even pressure to hold the tissues in firm apposition, and to prevent accumulation of blood or secretions under the flaps. The retention catheter that has already been placed just within the bladder may be brought out above or through the bandage, and the scrotum may be lightly supported with a pad included in the folds of the dressing. The retention catheter is given ordinary routine care and usually removed on the fourth day when the dressing is first changed, or before that if it becomes irritating.

An attempt is made to maintain this elevated position until complete healing has occurred, possibly longer.

In the second stage operation, in which the urethra is completed throughout the pendulous portion, the body is bent downward fixed to the scrotum. This changed position is maintained by practically the same type of dressing described but which is now applied to the dorsal surface, and must also support the scrotum. The new portion of urethra is constructed over a section of a fairly large catheter which may extend on into the bladder, or drainage may be maintained through a separate catheter introduced through the scrotal opening. It is highly important that the tube within the newly constructed section be retained at least 10 days.

At the third stage operation in which the body is freed from the scrotal flap and the urethra is completed, the penis is dressed against the abdomen as it was at the first operation. The catheter, at this time, of necessity traverses the whole urethra and is usually retained only a few days.

For one or a few days after each operative step, the catheter may be connected with a bedside bottle, but it is usually practical simply to close off the catheter and empty the bladder at intervals.

In adolescent and adult patients particularly the possibility of priapism must be forestalled. This might be disastrous, especially after the second operative step. For this purpose drugs are unreliable, but so far we have found the proper application of the pressure dressing described to be quite adequate. This pressure is usually maintained for a week or 10 days but after firm healing has occurred most patients are permitted to substitute a regular athletic supporter, not the simple suspensory, as a more comfortable method of fixation, which the patient can remove for urination and for sitz baths.

The same general ideas are carried out in dressing the cases of epispadias, except that the position of the catheter and of the penis itself have to be maintained differently.

The after-treatment of a successfully operated upon case is simply that sounds or catheters be passed regularly, as a rule starting after the first month, every 2 or 4 weeks for 1 year, but many patients do not go through with this plan and have no evidence of stricture.

The complication of epididymitis may occur in patients who have had old infections, but in ours such has not proved serious.

TRANSURETHRAL RESECTION OF OBSTRUCTIONS AT THE VESICAL ORIFICE[1]

HERMAN L. KRETSCHMER, M.D., F.A.C.S., CHICAGO

DURING the past 18 months a great deal of interest has been manifested in the non-surgical treatment of prostatic obstruction by means of the transurethral electric resection. Many advantages are claimed for this form of treatment, and certain objections have been advanced against it. With this, as with many other new forms of treatment, its adherents are enthusiastic, often to a degree beyond the limits of normal enthusiasm, and great, almost unbelievable, claims are made. The opponents set up objections that may have certain foundations in fact. It would seem, therefore, that the advantages and limitations of this form of treatment can be and will be determined only with the passing of time, during which many groups of cases will be reported and carefully analyzed and comparisons made with similar groups of cases that were treated by operation.

Let us discuss this new form of therapy under two headings: (a) its advantages over surgery, and (b) its limitations, if any, to effect a cure.

(a) The advantages over surgery are manifold. They may be briefly mentioned as follows:

1. The period of incapacity after operation is brief; hence the stay in the hospital is short.
2. The method can be applied to a group of patients who heretofore were classified as inoperable and hence were denied relief from prostatic suffering.
3. Patients will seek relief at a much earlier period.
4. Shock is eliminated.
5. It is of value in the treatment of carcinoma of the prostate.
6. It is of value in treating certain complications following surgical removal of the prostate.

1. *A shorter period of hospitalization.* It is generally recognized that the period of hospitalization in the average case of prostatectomy is a long one. It is possible, in certain well selected cases, to reduce this period, but short stays in the hospital are not the rule. The relatively long period of hospitalization is often due to the fact that patients enter the hospital late in the course of the disease; they have dreaded surgery, and therefore postpone the day of operation so long that severe infection takes place and there is frequently damage to the upper tract, the result of back pressure, as well as impaired cardiac function. In short, this group comprises what has been called bad surgical risks. In this field, as in any other field of major surgery, the poor risk patient always requires a longer period of preparation and complications more frequently follow operation and they are more numerous.

On the other hand, when the electric resectoscope is used the period of hospitalization is shorter and complications following treatment are reduced to a minimum. I do not believe that we have been in any particular hurry to discharge our patients from the hospital, no attempt has been made to hurry them, yet it is evident that they have remained less time in the hospital. This is of great advantage to the patient in these times of economic distress.

A review of this series of 162 resections performed on 148 patients shows that the average stay in the hospital was 9 days and in some cases the patient was hospitalized only 2 days.

2. *Application of this form of treatment to a group that heretofore was classified as inoperable and hence was denied relief from prostatic obstruction.* Because of its simplicity and relative freedom of complications this new procedure will be the means of obtaining relief from prostatic obstruction in a certain group of patients who could not be subjected to operative procedures. Patients with severe angina pectoris, for example, who could not be subjected even to a two stage prostatectomy, may now with safety be subjected to a transurethral resection. In this series we have had 7 cases of severe angina—patients who it was felt by the cardiologist could never have been able to stand a major surgical operation. And the same may be said for patients with broken compensation due to cardiac failure. Just as the two-stage operation has made relief available to an ever-increasing number of prostatics, so this new form of treatment will extend its field of application, and many patients, who are denied surgery, will be relieved of the obstruction.

3. *Patients will seek relief at a much earlier period.* Many men approaching the prostatic age come to the physician seeking information as to what they or their physician can do to prevent the development of impending prostatic trouble and its train of symptoms. If such patients can

[1] Read at the Annual Meeting of the Western Surgical Association, Madison, Wisconsin, December 9-10, 1932.

be assured that the prospects are good that a major surgical operation will be relatively free from danger and complications and that the stay in the hospital following such operation will not be long, much will have been accomplished in getting this group of sufferers to seek relief during the early stages of prostatism, and, if treated early, the distressing late symptoms can be completely avoided.

4. *The elimination of shock.* The advantage of the absence of shock in elderly men, particularly those who have severe cardiac disease and disturbances of blood pressure, either hypotension or hypertension, or who suffer from cardiac decompensation, is an exceedingly obvious one. When this procedure is carried out rapidly and when particular attention is paid to the control of hæmorrhage at the time of resection, the element of shock is practically eliminated.

5. *Its advantages in the treatment of carcinoma of the prostate.* The resectoscope has been found of great value in my hands in treating carcinoma of the prostate. It is a well recognized fact that prostatectomy in this type of case is sooner or later followed by a recurrence. As a matter of fact, the large percentage of recurrences has led practically to the complete abandonment of prostatectomy in cases of carcinoma.

Patients with carcinoma to be treated with the resectoscope may be divided into three groups:

a. Cases of recurrence. Those who have had a prostatectomy before coming under observation and who are again having symptoms that demand relief, such as frequency, pain, hæmaturia, or retention requiring the use of a catheter. In this group of cases the resectoscope has been of great value. It is possible to remove the obstructing carcinoma, so that complete urinary function is re-established. Should the carcinoma recur in several years it is a simple procedure to do a transurethral electroresection again.

b. Cases with suprapubic drainage. In many cases of carcinoma, especially in those seen late or relatively late in the course of the disease, a suprapubic cystostomy is done and the patient is doomed to wear his catheter until the end of his life. In just this particular type of case we have had the most gratifying results with the resectoscope, in that it has been possible to remove the obstructing carcinoma completely, with the result that the suprapubic fistula heals, thereby adding greatly to the patient's comfort.

c. Cases of carcinoma not operated upon previously. Whether one favors the use of radium or deep roentgen therapy for carcinoma makes little difference, since the form of treatment desired by the physician can be used after the carcinomatous obstruction has been relieved by means of the resectoscope.

6. *Its value in treating certain complications following surgical removal of the prostate.* The persistence of overlooked tags, small adenomatous nodules, and overlooked median bars or middle lobes, may be corrected with the resectoscope in a simple and easy manner. The same may be said for the treatment of the strictures at the internal urethral orifice following prostatectomy, although it must be admitted that stricture is very uncommon.

Objections to this form of treatment. One of the common objections is that this form of treatment will be followed by stricture with a return of the symptoms. This must await the passing of time to determine its validity.

The second and most frequent objection is based on the fact that the entire gland is not removed; hence recurrence may take place. Recurrences, it may be stressed, also occur following prostatectomy. However, should recurrences follow this new procedure it will be a relatively simple procedure to use the resectoscope again.

SELECTION OF CASES

Every patient with prostatic obstruction should be subjected to a complete physical examination even before instrumental examination is done. Lesions of the cardiovascular system occur in a large number of these patients. In a previous study it was shown that cardiac disease was present in 35.8 per cent in a series of 321 cases.[1] Many cardiac patients when first seen appear to be poor risks for operation. But, after careful preparation, the majority can be operated upon safely. Some cardiac patients can never be improved so that they can withstand surgery. It is in just this group of cases that transurethral prostatectomy can be carried out with a greater measure of safety than in major surgery. Patients who on account of bad hearts, have had a permanent suprapubic catheter in lieu of prostatectomy, have had a transurethral resection and the fistulæ have healed.

Many of this group also suffer from hypertension. The bad effect that infection, pain, and fatigue has on hypertension is well known. Hypertension is often greatly improved by the indwelling catheter, fluids, urinary antiseptics and rest in bed. Further diminution was noted after the resections, in some instances rather striking, as shown by the following table.

[1] Bacon, Kretschmer, and Woodruff. J. Am. M. Ass., 1931, xcvii, 1221–1223.

Before	After
260/112	158/90
190/104	150/84
196/110	116/78
188/120	150/90

Since this procedure is carried out under sacral anæsthesia, allowing change of position frequently, and since the patient can be allowed to leave his bed the next day, this procedure is particularly desirable in cases of asthma, chronic bronchitis and emphysema, its advantages being obvious.

CONTROL OF INFECTION

A large number of these patients when admitted to the hospital suffer from infection in the urinary tract, therefore efforts should be made to control the infection. In this series of 148 cases infection occurred in 89 cases. Cultures of the urine showed the following types of organisms.

BACTERIOLOGY

	Cases
Bacillus coli	36
Staphylococcus albus	38
Streptococcus hæmolyticus	7
Staphylococcus hæmolyticus	4
Bacillus coli hæmolyticus	2
Eberthella	1
Bacillus proteus	1
Total	89

In the preresection treatment of infection the following procedures were employed: (1) intermittent catheterization and injection; (2) indwelling urethral catheter; (3) suprapubic cystostomy.

1. *Intermittent catheterization and injection.* This procedure was reserved for a small group of cases. It should be borne in mind that even when the greatest care is exercised this method is open to the criticism of added infection.

2. *Indwelling urethral catheter.* This was the method of preparation in the largest number of cases showing infection. For preliminary drainage a small catheter is given preference, and care to avoid trauma should be exercised when it is passed. Daily bladder lavage with potassium permanganate was used. The catheter should be changed frequently.

3. *Suprapubic cystostomy.* In the present status of this subject, a group of cases will be seen that for one reason or another will need a suprapubic cystostomy. These are generally the patients who should undergo prolonged drainage, but who cannot be treated by means of the indwelling catheter. In some patients the indwelling catheter is responsible for severe pain in the urethra, and also for a profuse urethral discharge with its inherent dangers of a periurethral abscess. In other patients it causes severe bleeding which frequently plugs the catheter and necessarily interferes with drainage; sometimes the bladder becomes filled with blood clots. And finally, in a certain number, the indwelling catheter provokes in a short time severe chills, fever, and sweats.

It is my opinion that because of this sequence of events, the best course to pursue is to perform a rapid cystostomy under local anæsthesia.

Objections have been advanced against a suprapubic cystostomy when a transurethral resection is contemplated. Transurethral resection can be done just as well when the bladder is open as when it is not open, and in cases in which I was convinced that a suprapubic cystotomy was indicated, I have carried it out without hesitation.

The following table shows the methods employed in the preparation of this group of patients.

	Cases
Indwelling urethral catheter	58
Suprapubic cystotomy	22
Massage and bladder irrigation	21
No preparation	47
Total	148

POSTOPERATIVE COURSE

Bleeding. Immediate postoperative bleeding is generally of minor importance, the amount being dependent on the care that was exercised in the control of bleeding at the time of the resection. It is my opinion that the time and place to control the bleeding is in the operating room while the resection is being done. We try to send the patient back to the ward or room with little or no bleeding, and this is easy of accomplishment, experience and patience being essential.

Late hæmorrhage. It is but reasonable to expect late secondary bleeding in this form of surgery just as we meet this condition either in suprapubic or perineal prostatectomy. We have had only 7 occurrences, neither of which was alarming. The patients were readmitted to the hospital with suprapubic tumors, that is, their bladders were filled with urine and clots. Evacuation was done by means of a Bigelow pump, and then irrigation with warm potassium permanganate sufficient to control the oozing, was instituted.

Temperature. In going over our records we have been greatly impressed by the fact that the febrile reactions are less in number, the temperature range not so high, and the duration of the fever of a much shorter time than is the case when major surgery is resorted to.

The following table shows the postoperative temperatures in this group.

Average length of time.....3.2 days
Temperature 1–2 days only 83 cases

Degrees	Cases
98.6 to 99	15
99 to 100	43
100 to 101	53
101 to 102	26
102 to 103	17
103 to 104	8
Total resections	162

Epididymitis. Epididymitis is a very troublesome complication and as a sequence of surgical removal occurs in about 25 per cent of the cases. Our present series shows 12 per cent. In the majority of cases epididymitis develops after the patients leave the hospital. But, it may be stated as a fact that this annoying complication can be absolutely prevented by a resection of a piece of the vas deferens; as a rule, I resect about 1 inch.

MORTALITY

The results obtained seem to justify the statements that have been repeatedly made that this new form of treatment carries with it a much lower mortality rate, and this in spite of the fact that many patients are operated upon by this method who have been denied surgery because they have been classified as inoperable. My records show that the mortality following 162 transurethral resections was 3.08 per cent.

CONCLUSIONS

I cannot emphasize sufficiently the definite advantages that this new method has over major surgery in treating vesical neck obstructions, hence it seems to me right and proper to reiterate them:

1. The period of illness is much shorter as is the stay in the hospital.
2. Shock is eliminated.
3. Patients will seek relief at a much earlier period than they do at present.
4. A certain number of patients suffering from prostatic obstruction will no longer be denied the possibility of obtaining relief.
5. The new method obviates permanent suprapubic drainage in cases of carcinoma of the prostate.
6. Strictures, contractures, and overlooked bars following prostatectomy may be treated.

NON-OPERATIVE TREATMENT OF FRACTURES OF THE TIBIA AND FEMUR INVOLVING THE KNEE JOINT[1]

ELDRIDGE L. ELIASON, M.D., F.A.C.S., PHILADELPHIA
AND
WALTER W. EBELING, M.D., PHILADELPHIA
Hunter Fellow in Surgery

THE interest manifest in those fractures which occur in the immediate vicinity of the knee joint, depends not so much upon their frequency or degree of bone alteration as on the threat imposed upon the integrity of that joint. When the fracture lines extend on to the joint surface, either from the femoral or tibial side, it has long been assumed that the knee joint function may be seriously, if not permanently, impaired. Whether the sequelæ of these injuries depend upon the distortion of the articular and weight bearing planes, or ligamentous and cartilaginous tear, remains to be shown.

In order that the relationship of these fractures of the femoral condyles and tibial head to ultimate joint function might be more clearly understood, this review of those fractures cared for on Surgical Division "C" and in the Surgical Out-Patient Department at the Hospital of the University of Pennsylvania, during the past 10 years, was undertaken.

Anatomical considerations. The knee joint, so situated between the longest bones in the skeleton, is subject to frequent and unusual strain. Collins believes the knee joint to be one of the weakest joints. If such were the case, dislocation would occur with greater frequency. A modification of his statement might be blended to read "despite the fact that the knee joint is the largest joint in the body, its strength in large part depends upon the multiplicity of muscles, tendons, and ligaments entering into its structural support." The most important of these ligaments arise from the bones intimately to and immediately supporting the weight bearing, articular surfaces. Stability in part depends upon the maintenance of the weight bearing planes (condyles and tibial plateau) in their true relationship.

Frequency. In a review of 10,399 fractures, Nelson's *Surgery* places the incidence of fractures of the femur at 743, or 7.14 per cent. Of these, 82 were of the lower end of the femur, 55 per cent of which involved the condyles. The ratio between the internal, external, and both condyles was given as 5: 3: 4. Of 549 fractures of the tibia, 104, or 19 per cent, were of the upper end, 83 per cent of which involved the head.

In over 13,000 fractures now on record in the files of the Department of Roentgenology at the Hospital of the University of Pennsylvania, from which files the above data were collected, there were 186 fractures involving the knee joint, or about 1.4 per cent. Of this group, 52, or 28 per cent, involved the condyles of the femur. One hundred and thirty-four affected the head of the tibia, either through the tuberosities or spine. For comparison these fractures have been collected in Table I.

Of the femoral condyles, the external condyle was involved in over half the cases. Of those fractures through the tibial head, the external tuberosity was fractured more frequently. This fact would tend to support direct trauma as being responsible for the major portion of knee joint fractures, since it is the outer and exposed side of either bone that is most frequently injured.

The fractures collected in Table II represent those cases cared for by Surgical Division "C" and the Surgical Out-Patient Department for the past 10 years.

Ollershaw stated that fracture of the articular surfaces of the knee joint comprised about 2 per cent of all fractures. Barbilian, in a review of 335 fractures of the leg, placed the incidence of tibial plateau fractures at 3.8 per cent. Steuer, in 1300 fractures, found tibial involvement in 5 per cent. Of the 66 fractures of the tibia, 16 or 1.2 per cent involved the articular surfaces of the knee joint.

Cutler, in a recent report, observed 7 fractures occurring between the condyles of the femur, 5 of the external condyle, and 3 of the internal condyle. The relative frequency of fractures involving both condyles is greater than that observed in Table I.

The male, for obvious reasons suffered by far more fractures than the female. The greatest proportion of these fractures occurred in the adult and active period of life. But few were observed before 20 years, and fewer still after 60 (Table III, A and B).

Etiology. A "bumper fracture" as the name implies, is the result of a direct blow at the knee by an automobile bumper. Cary admits of a complex fracture, involving the external tuber-

[1] From Surgical Division "C"—Dr. E. L. Eliason—Hospital of the University of Pennsylvania. Read at the Philadelphia meeting of the Committee on the Treatment of Fractures of The American College of Surgeons, Philadelphia, January 14, 1933.

TABLE I.—FRACTURES ABOUT THE KNEE JOINT

Relative Incidence[1]

Site	Cases	Per cent
Femoral condyles	52	28
Both	11	21
Internal	15	29
External	26	50
Tibial head	134	72
Spine	17	12.6
Tuberosities	117	87.4
Both	5	6.2
Internal	16	20
External	53	66.3
Anterior part	2	2.5
Posterior part	4	5

[1]The above data are collected from the files of the Department of Roentgenology at the Hospital of the University of Pennsylvania.

TABLE II.—FRACTURES ABOUT THE KNEE JOINT

Relative Incidence[1]

Site	Cases	Per cent
Femoral condyles	6	15
Both	0	0
Internal	3	50
External	3	50
Tibial head	34	85
Spine	4	12
Tuberosities	30	88
Both	4	13
Internal	9	30
External	15	50
Anterior part	1	3.5
Posterior part	1	3.5

[1]The above data represent the relative distribution of the fractures about the knee joint, of those cases on which this study was based.

osity of the head of the tibia with an avulsion of the tibiofibular joint and rupture of the external lateral ligament of the knee joint. He added as associated injuries, fractures of both tuberosities of the tibia, fractures of the condyles of the femur, and fractures of the tibial spine.

Rupture of the crucial ligaments and injury to the semilunar cartilages were included. He was, however, unable to find injury to either in early cases operated upon. In later cases, where preternatural anteroposterior movement was used as a criterion for a diagnosis of crucial ligament rupture, none were observed. It would appear that one could not be assured of crucial ligament rupture, or tear of the external lateral ligament without open operation.

The automobile bumper was responsible for 13 of the 40 fractures collected under Table II. The external tuberosity of the tibia was involved in 6, the internal tuberosity in 4, and both tuberosities in 2 cases. The internal condyle of the femur was fractured in 1 case. If the patients fell down stairs, usually doubling the extremity under the body, the external tuberosity was fractured four times. Football tackles were responsible for 2 fractures. Cowl injuries, the result of head-on auto collisions, were responsible for 2 fractures. In 14 cases falls were recorded, and in 5, the nature of the injury was not mentioned.

Collins found the automobile bumper responsible for 36 per cent of those fractures of the tibial head.

The mechanics of these fractures is not without interest. Barbilian, quoted by Collins, was unable to produce fractures of the tibial head by mere internal or external torsion. When to torsion there was added a direct blow, the fracture resulted.

Cary believed that the degree of violence was commonly insufficient in itself to produce the extensive injury one often sees. He added that muscular action played an important part, though the trauma was the primary cause.

In extension the knee joint is unusually powerful, while in flexion most unstable. When the fracture force is so directed against the external aspect of the knee as to produce a genu valgum, the tibial head, particularly the external tuberosity, with the fibula or the external condyle of the femur may be fractured. When the force is so directed against the internal aspect of the knee, as to produce a genu varum, the internal tuber-

TABLE III.—FRACTURES ABOUT THE KNEE JOINT. AGE—INCIDENCE

A[1]

Site	Under 20 yrs.		21 to 40 yrs.		41 to 60 yrs.		Over 60 yrs.	
	Cases	Per cent	Cases	Per cent	Cases	Per cent	Cases	Per cent
Femoral condyles (52 cases)	13	25	15	29	21	40	3	6
Tibial head Spine (17 cases)	1	6	8	47	8	47		
Tuberosities (117 cases)	12	11	50	43	44	37	11	9

[1]The above data were collected from the files of the Department of Roentgenology at the Hospital of the University of Pennsylvania.

B[2]

Femoral condyles (6 cases)	3	50			3	50		
Tibial head Spine (4 cases)	1	25	2	50	1	25		
Tuberosities (30 cases)	2	7	12	40	14	46	2	7

[2]This latter group represents the age distribution of those cases on which this study is based.

TABLE IV.—FRACTURES OF THE EXTERNAL TUBEROSITY OF THE TIBIA

Case	Extent of bone injury	Last follow-up report	Class
1	Comminuted, crushed fracture with widening of the joint surface, plus fracture of the head of the fibula	8½ years after injury. Walks without limp. No pain. Full extension or flexion. No preternatural mobility. Favors knee when walking up stairs	4?-4-4
2	Comminuted, crushed fracture, with widening of the joint surface	No follow-up	
3	Comminuted, crushed fracture, involving the articular surface as far as the spine. Plus comminuted fracture of the head of the fibula	Four years after injury. No pain, weakness or deformity. Not afraid to bear full weight. After long walk through woods or over hills, knee will feel lazy and tired. Recovers in an hour	4?-4-4
4	Comminuted, crushed fracture, of outer and posterior aspect, with widening of joint surface, irregularity in contour. Plus fracture of head of fibula	7½ months after injury. No weakness. No complaints. Complete return of function	4?-4-4
5	Comminuted fracture, longitudinal into the joint at spine, with irregularity of articular surface at the spine	3 months after injury. Reported a perfect result	4?-4-4
6	Comminuted, crushed fracture with considerable irregularity at the articular surface, with widening of the plateau	27 months after injury. Not the slightest complaint. Plays 18 to 36 holes of golf 5 days in succession. Would not know knee had been injured	4?-4-4
7	Crushed fracture of outer one-third, with upward displacement, and posterior displacement. Comminuted fracture of the head of the fibula	7 years after injury. No deformity. No pain or disability. No limitation of motion. No weakness. Does not favor knee	4?-4-4
8	Crushed fracture of the outer one-third, with downward and posterior displacement of fragment	No follow-up. Neighbor said she had no symptoms	
9	Comminuted, crushed fracture with widening of the plateau. Probable sprain fracture of the femur, above	3 years after injury. No pain, weakness or deformity. Says knee is better than other in which she has rheumatism. Would not know knee had been injured	4?-4-4
10	Comminuted, crushed fracture with widening of the plateau. Possible fracture of spine	3 years after injury. No pain, weakness or deformity. Has frequently run for a trolly without discomfort. Knee is as good as other	4?-4-4
11	Fracture line extends through the articular surface at its middle, down and obliquely to the external part of the shaft. Good position	1 year and 8 months after injury. No pain, weakness or limitation of motion. A tight joint. As good as other knee. Plays eighteen holes of golf without discomfort	4?-4-4
12	Fracture line starts at spine of tibia and extends downward for a distance of about three inches. Good position	5 months after injury. Not as strong as other knee. Pains in damp weather. Walks with a tendency to favor that knee	4?-3-4
13	Fracture produces considerable cleft at outer portion of articular surface	9 months after injury. No weakness, or deformity. Walks normally. Slight discomfort in wet weather	4?-4-4
14	Fracture of the external tuberosity, with fragments in good position. External condyle of femur split off	No follow-up. His physician thinks he had a perfect result, but is not sure	
15	Fracture involves the outer portion, possibly in the nature of a sprain fracture	5 years after injury. Knee is as strong as its fellow. No pain or deformity. No tendency to favor when walking	4?-4-4

FRACTURES OF THE INTERNAL TUBEROSITY OF THE TIBIA

16	Comminuted fracture of the plateau. Fragments in good position	5 years after injury. No discomfort, interference with function, or limp. No deformity	4?-4-4
17	Oblique fracture line up through the shaft, entering the joint surface. Fragments in good position. Plus upper third of fibula	10 months after injury. No deformity, weakness. Good joint function. Occasional pain on walking. Tenderness over internal tuberosity	4?-3-3
18	Comminuted fracture, with crush and widening of the plateau, showing downward and posterior displacement	No follow-up	
19	Comminuted, crushed fracture, with downward and posterior displacement of entire tuberosity, fracture line involves the spine. Plus fracture of the head of the fibula	4 years after injury. There is pain, weakness and swelling. Afraid to bear full weight on leg. Limps and drags foot. Shortening	2-2-2
20	Oblique fracture line, extending from shaft below the tuberosity, to come out on the joint surface of the external tuberosity. Good position	5 years after injury. No pain, weakness or deformity. Does not favor knee when walking. Not afraid to bear full weight. Knee as strong as fellow	4?-4-4
21	Crush fracture of the peripheral one-fourth of articular surface	One year after injury. Pain and tenderness over inner tuberosity. Good function. No limitation of motion. Weight bearing without symptoms	4?-3-4
22	Comminuted fracture of the neck of the tibia, with the fracture line extending between the tubercles of the spine. Downward displacement of the inner tuberosity. Articulating surface in good position	1 year and 6 months after injury. Knee is as good as its fellow. No pain, weakness or limitation of motion. No preternatural mobility. Does not favor knee when walking.	4?-4-4
23	Fracture through the peripheral one-fourth of the tuberosity. Fragment in good position	5½ years after injury. No pain or deformity. No weakness. Perfect function, except that knee occasionally locks	3-3-4
24	Fracture through the inner aspect of the articular surface, with some solution of the smaller fragments. Many loose bodies in joint. Knock knee. Suggests Charcot's joint	Final diagnosis was Charcot's joint	Drop

TABLE IV.—FRACTURES OF BOTH TUBEROSITIES OF THE TIBIA—Continued

Case	Extent of bone injury	Last follow-up report	Class
25	Compound, comminuted, crushed fracture of the head, with lines entering the articulating surface. Good position	9 years after injury. Joint is ankylosed. A sequestra was removed 4 years ago	0-2-3
26	Comminuted, crushed fracture of the head, with fracture lines extending onto the articulating surface. Good position	1 year after injury. No complaint whatsoever. No pain, weakness or limitation of motion. No preternatural mobility	4?-4-4
27	Crushed fracture of the tibial head, the crush especially involving the posterior part	10 years after injury. There is a bowing deformity, with disability. Wears a walking brace while at work	2-3-3
28	Outer tuberosity involved by a longitudinal line extending onto the joint surface. Inner head probably a sprain fracture. Good position	5 months after injury. No pain. Walks without a limp. Does not favor knee. Complete freedom of motion. No preternatural mobility	4?-4-4
	FRACTURES INVOLVING THE ANTERIOR AND POSTERIOR PART OF TIBIAL HEAD		
29	Fracture involved the anterior part of the head, with but little displacement of the fragment	5 months after injury. There was good asymptomatic function	4?-4-4
30	Fracture involved the posterior part of the head, or tibial shelf. There was no displacement of the fragment	8 years after injury. No pain, weakness or disability. Not afraid to bear full weight	4?-4-4
	FRACTURES OF THE SPINE OF THE TIBIA		
31	External tubercle of the spine. Good position	3 months after injury. No complaints. Working as a waiter	4?-4-4
32	Through the base of the spine, below the external tubercle. Good position	8 months after injury. No residual symptoms whatsoever. Did not recall which knee was injured	4?-4-4
33	Through the base of the spine, below the internal tubercle. Good position	No follow-up	
34	External tubercle of the spine. Good position	Six years after injury. No complaint. Does not favor knee when walking	4?-4-4
	FRACTURES OF THE CONDYLES OF THE FEMUR		
35	Comminuted fracture of the internal condyle. Slight posterior rotation, but otherwise good position. Plus a comminuted fracture of head of fibula	5 months after injury. Flexion limited to about 50 degrees. No pain or deformity. Slight weakness. No preternatural mobility. Walks normally	4?-3-3
36	Longitudinal fracture through the lower end of the femur, splitting of the external condyle. Good position	6 months after injury, there was a complete return of function, without pain, deformity or limitation of motion. No weakness	4?-4-4
37	Fracture in which a portion of the articular surface of the internal condyle was completely separated	5 years after injury. No pain, weakness, disability or deformity. No fear of bearing full weight. Does not favor when walking	4?-4-4
38	Sprain type of fracture of the outer portion of the external condyle	13 months after injury. Wears an elastic support about the knee. Slight weakness. Does not favor when walking. Takes part in athletics	4?-3-4
39	Sprain type of fracture of the medial or inner aspect of the internal condyle	No follow-up	
40	Sprain type of fracture of the outer part of the external condyle	16 months after injury. No deformity. Examination revealed no weakness, unusual tenderness, or preternatural mobility. There was no limitation of motion. According to his statement, his knee was weak, painful and wobbly. He was still using crutches. A compensation case	4?-2-0

osity or the internal condyle may be fractured. On whatever degree of flexion of the knee at the time of direct trauma will depend the point of contact of the femoral condyles with the tibial plateau. In flexion the posterior portion of the tibial plateau, or shelf, would tend to be crushed, while in extension, the crush would be more anterior, with a resultant "back knee." When to this simple mechanism one adds forcible torsion, lateral or posterior displacement, it does not require any too vivid imagination to reconstruct the forces employed in the production of these, sometimes, complex fractures.

Deformity. The knee joint may be swollen, depending on the amount of effusion. A rapid swelling would suggest intra-articular hæmorrhage, and when delayed, probably serous. The knee will be held in partial flexion, and further flexion or extension will be limited. Depending on the displacement of the condyles of the femur, or tuberosities of the tibia, will depend the degree of genu varum or valgum. For the same reason, "back knee" will depend on the downward displacement of the tibial plateau. In the absence of swelling, the degree of displacement of the bony fragments may be discerned, and especially, widening of the tibial plateau.

Preternatural anteroposterior movement might indicate rupture of the crucial ligaments. One would hardly be justified in the elicitation of this

sign without anæsthesia, due to pain on motion of the injured joint. After induction of anæsthesia and with muscular relaxation, one cannot be positive. Cary failed to find this anteroposterior preternatural mobility in 12 cases in which this particular point was given attention.

A positive diagnosis of frank ligamentous tear can be made by open operation. This would appear to be unjustifiable in any case. One's attention is immediately attracted to those sprain fractures or osteochondral separations, marking the site of the attachment of the crucial ligaments. Wagner, Bernard, and Krida believed them to be true sprain fractures of the crucial ligaments. If this be true, it would appear that one might expect such, rather than a true tear or rupture of the crucial ligaments.

Diagnosis. It seems, therefore, in this injury that the time has come when we must depart from the methods of diagnosis based upon the careful history of injury, symptoms and physical signs. This triad has resulted in too frequent disaster, through failure to make the proper diagnosis. It may seem heretic to suggest that one minimize these methods handed down to us through long periods of practice.

With the history of trauma sufficient to produce any one of the signs or symptoms of a fracture, that is, deformity, crepitus, preternatural mobility, loss of function, pain, swelling, or discoloration, *diagnosis should be confirmed or disproved through an early and suitable roentgenological examination.* Recalling that pain is usually the predominant symptom in those fractures about the knee joint, this symptom alone should lead one to X-ray examination of the part involved. Until we have had suitable roentgenological studies, and not until then are we exonerated at point of law in failure to make a fracture diagnosis.

Extent of bony injury. In the collected series of 40 cases, the character of the fractures have been tabulated to permit of some appreciation of the extent of bone damage (Table IV). A few of the fracture roentgenograms have been reproduced, the description of each bearing the case number corresponding to that in Table IV. Each plate represents the position of the bony fragments after reduction.

Varying alterations in the head of the tibia were observed. Widening of the tibial plateau was frequent. There was usually comminution due to a crushing injury. The degree of displacement was variable. In 14 of 27 patients admitted to the hospital, the position of the bony fragments was considered sufficiently good to demand no further correction.

It is probably safe to add that the degree of alteration of the tibial plateau, and especially the articular facets, was never appreciated to its fullest extent, by the usual anteroposterior and lateral roentgenograms. With the knee in partial flexion, an anteroposterior roentgenogram may be produced, which will show more of the detail of the tibial plateau.

Fractures of the tibial spine, though few in number, were found to involve the base of the spine. It may be that those fractures at the bases represent sprain fractures of the crucial ligaments. Fractures of the tubercle could represent either a dislodgement of the semilunar cartilages, or more likely, the result of forcible contact with the mesial surfaces of the femoral condyles with which they are in close relation.

The fractures involving the anterior and posterior portions of the tibial head (Cases 29 and 30) could probably have been classed under those of the tibial spine.

Fractures of the femoral condyles were represented in their simpler form, that of the single condyle, or as a sprain fracture.

Associated and related injuries. In 5 fractures of the external tuberosity of the tibia, there was an associated fracture of the head of the fibula. In 2 of the fractures of the internal tuberosity of the tibia there was also a fracture of the head of the fibula. With a total of 30 fractures of the tibial tuberosities, this incidence of 7 fibular fractures would place the frequency of fractures of the head of the fibula with the tuberosities of the tibia at about 23 per cent.

In 2 cases there was both a fracture of the tibia and femur into the one knee joint, while other associated fractures involved the humerus in 2, the bones of the opposite leg in 4, and in individual cases the ulna, the clavicle, the pelvis, the ribs, the malar and nasal bones.

Treatment. Twenty-seven patients came directly under the care of Surgical Division "C." All of these fractures were treated as surgical emergencies.

In cases in which reposition of the fragments was needed, the technique was fairly simple. With the patient reclining on the fluoroscopic table, and under anæsthesia, traction in a longitudinal direction was made on the affected extremity. The patient was fixed to the table by means of a padded perineal post. A Collin's cinch to the ankle, and passed around the waist of a third assistant furnished sufficient traction force. The operator, guided by the fluoroscope, attempted to mold the bony fragments into suitable position. In some, this could be accomplished man-

Fig. 1a.

Fig. 1b.

Fig. 1. Case 1. a, Before operation; b, result 8½ months after operation.

Fig. 2.

Fig. 3.

Fig. 2. Case 2. Condition before treatment.
Fig. 3. Case 3. Before treatment.

ually, in others molding was aided by the application of a Spanish windlass. The latter procedure was especially applicable to those fractures about the tibial head. No more forcible measures were recorded.

Attention was particularly focused toward the replacement of the weight bearing planes to their proper relationship. In so doing, any genu varum or valgum, or "back knee" was corrected.

After reduction, lateral, molded, plaster-of-paris splints were applied, extending from the perineum, down to and around the foot. During their application, the longitudinal traction was maintained, and the knee manipulated as little as possible. The knee was immobilized in slight flexion.

The anæsthetic employed depended largely upon the patient, open drop ether or nitrous oxide were used frequently. Recently spinal anæsthesia has been employed with much satisfaction.

None of the 40 cases recorded required open reduction.

For those patients admitted to the hospital, the average period of hospitalization was 26 days, with a minimum of a day and a maximum of 95 days.

The molded plaster-of-paris splints were removed at frequent intervals to permit of care of the soft parts.

Cotton and Berg have advised against open operation in the crushing fractures of the external tuberosity of the tibia. Their closed method comprises a jamming back of the fragment to where it came from, mainly upward replacement.

Cary described elaborately his method of reduction. He did not employ the fluoroscope. Fixation was accomplished by plaster.

Bernard considered fractures of the tibial spine, and called attention to the necessity of open reduction when the lateral meniscus would not permit a closed replacement of the fragment.

Cubbins reported an unusual fracture in which the lateral meniscus was dislocated between the fragments comprising the external tuberosity and the head of the tibia. He advised open operation.

There are some few injuries which may be grouped with "osteitis desiccans" in which the major manifestations are those of free joint body, and in which their removal completely relieves the patients of symptoms or disability.

Cutler in a review of 38 fractures of the condyles of the femur, 15 of which involved the knee joint, called attention to their successful treatment by closed methods. Fractures of a single condyle were usually replaced without open operation and maintained in a plaster dressing. Where both condyles were involved, with traction and plaster he obtained good results. Further attention was called to the advice of Scudder, Speed, Cotton, and Wilson and Cochrane on this subject.

Period of disability. The termination of the average period of disability was extremely difficult. It has always appeared to be of little importance, so long as the patient, some time in the near future may be assured a good and useful extremity. However, in accordance with the usual custom, an approximate idea was obtained.

The plaster-of-paris splints were usually removed at about the sixth week. Where the fracture involved the tibial head, the patient was usually able to walk without the aid of a cane or crutch at about the third month. Several apparently needed the support of a cane or crutch a much longer period of time, up to 1 year. In a

Fig. 4a. Fig. 4b.

Fig. 4. Case 4. Before and after treatment.

Fig. 5a. Fig. 5b.

Fig. 5. Case 16. Before and after treatment.

few cases the disability was in all probability permanent, though not complete (Cases 19, 25 and 27).

Complete return of function to the knee joint, as estimated on the basis of stability and strength as compared to the opposite knee joint, and absence of untoward symptoms, was evident at about the fifth month, and from then on up to as much as 2 years.

When the fracture was in the nature of a sprain fracture, walking without support was possible at about the fourth month. One patient (Case 40) was using crutches after 15 months. The fact that this particular patient was receiving the benefits of a workman's compensation as a result of this injury, may explain this unusual discrepancy.

If the tibial spine was involved, without fracture of the tuberosities of the tibia, the period of disability was short, 2 weeks in 1 case, and 2½ months in another.

In those fractures of the femoral condyles, the patient was able to walk without the aid of additional support, after 4 months. From that time on, up until 1 year, there was complete return of function.

Swett advised 6 weeks' immobilization for fractures of the tibial head, with knee joint involvement. Ollershaw, reviewing fractures of the femur as well as those of the tibial head, agreed with the above period of immobilization. He further advised weight bearing after 3 months. In some of his cases, 18 months were required for complete return of function.

Collins immobilized for but 1 month, which was then followed by gradual mobilization until complete recovery. His fractures were limited to the head of the tibia. Cotton permitted weight bearing in about 8 weeks.

Each fracture should be treated according to its particular needs. As a rough guide, indeed, one may immobilize those fractures which involve the knee joint for about 6 weeks. After removal of whatever method of immobilization, guided active motion may be permitted, to re-establish joint motion, and to encourage return of muscular support. Weight bearing may be begun at the third month in those fractures which involve the tibial head. When the fracture involves the condyles of the femur, weight bearing may be permitted after 4 months. Complete return of function is not to be expected for about 6 months, and then, depending on individual circumstances. Some may take longer, as long as 2 years. After this time, one may expect that whatever disability remains, may be permanent.

Results. In order that one might correlate to some degree the extent of bone injury with the ultimate result, all cases have been tabulated (Table IV) with their last follow-up report, and classification. One (Case 24) undoubtedly a Charcot joint was omitted in the summation of these statistics. Of the remaining 39 patients 33, or 84 per cent, were followed.

The results have been classified on the basis of complete anatomic, symptomatic, and economic recovery, after the method originating at the Massachusetts General Hospital. The figure 4[1] represents a 75 to 100 per cent anatomical restoration. It would appear unnecessary, and in fact extremely difficult to attempt a closer definition of anatomic restoration. This definition must be based on the gross appearance of the knee, its conformation and alinement. When the anatomical restoration is judged from the roentgenogram no single case would rate an anatomical 4.

Where the correct relationship of the weight bearing planes has been restored, and the patient or examiner admits of no deformity and an ab-

[1]Despite roentgenographic appearance.

Fig. 6a.

Fig. 6b.

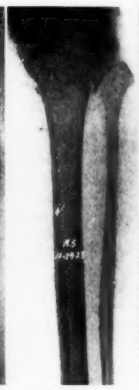


Fig. 7a.

Fig. 7b.

Fig. 8a.

Fig. 8b.

Fig. 6. Case 17. Before and after treatment.
Fig. 7. Case 25. Before and after treatment.

Fig. 8. Case 26. Before treatment; anteroposterior and lateral views.

sence or preternatural mobility, one must admit of a 4? anatomical result. Where function has been completely restored, in the knee joint particularly, functional restoration depends in large part on anatomic restoration.

A second figure 4 represents a complete absence of symptoms, and a last 4 signifies a full economic restoration.

For example: 4?–3–2 would signify 75 to 100 per cent anatomic restoration, 50 to 75 per cent symptomatic relief and from 25 to 50 per cent economic recovery.

The follow-up reports are summarized for each type of fracture:

External tuberosity of the tibia. Of 15 patients 12 were followed. Eleven of the 12, or 91 per cent presented 4?–4–4 results.

Internal tuberosity of the tibia. Seven out of 8 patients were followed. Three or 43 per cent, presented 4?-4-4 results.

Fractures of both tuberosities. All 4 patients were followed. Two cases presented 4?-4-4 results. One case (Case 25) represents the result of a compound fracture. Another case (Case 27) undoubtedly represents a fracture wreck, the result of too early weight bearing, or poor fixation.

Fractures of the anterior and posterior portion of the tibial head, and the spine. Five patients reported and all presented 4?-4-4 results. All represented good anatomical reposition of the bony fragments.

Fractures of the condyles of the femur. Five of the 6 patients reported. But 2 at this time presented 4?-4-4 results. To this group it would appear fair to include 2 cases (Cases 35 and 38), which after a longer period of convalescence may be expected to report more favorably. One case (Case 40) a sprain fracture, hobbling about on crutches after 15 months, represents a gross failure on the part of the workmen's compensation.

The follow-up reports have been considered from the standpoint of their relationship to a good anatomical restoration of the bones involved or to a poor anatomical restoration.

In the fractures of the external tuberosity of the tibia, 5 showed a good anatomical reposition of the bony fragments in the post reduction roentgenogram. All practically have presented 4?-4-4 results. One, at 5 months had slight pain on walking. In 7 fractures, in which the postreduction roentgenogram showed but a poor anatomical reposition of the bony fragments, all reported favorably.

In those fractures of the internal tuberosity of the tibia, 6 showed a good reposition of the bony fragments in the postreduction roentgenogram, 5 of which to all practical purposes presented 4?-4-4 results. Two have been reported at 10 months, and 1 year, prior to the completion of convalescence. In but 1 fracture, where a poor anatomic restoration was recorded by the postreduction roentgenogram (Case 19) the ultimate result was poor.

For the entire group of 33 patients followed, 4?-4-4 results were recorded in 70 per cent. With a longer period of convalescence in a few patients, a better report may be expected. Of the remainder, with the exception of the patient (Case 25), who suffered a compound fracture, there were only minor deformities; a few symptoms in the

Fig. 9a.

Fig. 9b.

Fig. 9. Case 27. Before and after treatment.

Fig. 10.

Fig. 10. Case 32. Before treatment.

Fig. 11.

Fig. 11. Case 35. Before treatment.

Fig. 12.

Fig. 12. Case 36. Before treatment.

order of occasional pain, or weakness and instability of a lesser degree, and but slight economic impairment as a result of the injury. There were no cases of non-union. One case (Case 23) had a resultant, loose semilunar cartilage.

In several patients the follow-up data has extended beyond a period of 5 years (Cases 1, 7, 15, 16, 20, 23, 27, 30, 34, and 37). In none of these could the ultimate results have been interpreted as being complicated by an arthritis. All of these with but 2 exceptions (Cases 23 and 27) presented 4?-4-4 results. Attention has been called to the occurrence of chronic arthritis by Collins.

SUMMARY

A series of 40 fractures of the tibial head and femoral condyles has been presented. All were treated by closed methods. None were reduced at open operation. For those patients admitted to the hospital, treatment mainly consisted of an early fluoroscopically controlled reduction, under a selected anæsthesia. Immobilization was accomplished with molded plaster-of-paris splints. Splints were usually removed at the end of 6 weeks. Weight bearing was permitted at about the third month in those fractures of the tibial head. Weight bearing was permitted at about the fourth month in those fractures of the condyles of the femur. Complete return of function was observed at about the sixth month, and on up to the second year.

Eighty-four per cent of 39 fractures were followed. Seventy per cent presented 4?-4-4 results.

On the basis of this data it appears justifiable to conclude that the closed method for the treatment of fractures of the tibial head and femoral condyles, which enter upon the knee joint, offers satisfactory results in even particularly severe injuries, where attention is paid to early reduction with individual judgment as to the need of a cabinet maker's restitution of fragments, followed by ample protection during convalescence.

CASE 1. E. I., female, aged 33 years. X-ray examination showed a comminuted, crushed fracture of the head of the left tibia, with special involvement of the external tuberosity and considerable widening of the joint surface. The head of the fibula was likewise fractured (Fig. 1a).

Sixteen months after the injury, the patient wrote that she felt no ill effects from the fracture. She was examined about 8½ years after fracture. She walked without a limp. There was no limitation of motion, nor was there preternatural mobility. She suffered no pain either when weight bearing or walking. She stated that when walking up stairs, she tended to favor the left knee slightly.

X-ray examination at this time showed the fragments united in good position (Fig. 1b).

Class—4?-4-4.

CASE 2. J. W., male, aged 35 years. X-ray examination showed a comminuted, crushed fracture of the external tuberosity of the head of the left tibia, with widening of the tibial plateau (Fig. 2). Lateral molded plaster splints were applied 2 days later. He was discharged from the hospital seven days after injury. The splints were in place, and he was up on crutches.

No follow-up.

CASE 3. H. G., male, aged 53 years. X-ray examination showed a comminuted, crushed fracture of the external tuberosity of the left tibia, involving the articular surface as far as the spine. In addition there was a comminuted fracture of the head of the fibula, with comminution of the shaft (Fig. 3). Approximately thirteen months after injury he was doing light farm work, and although he stated that his knee was weak and wobbly, he was able to walk upstairs without difficulty.

In reply to a questionnaire about 4 years after injury, the patient stated that it was fully 2 years before his knee appeared to be as strong as it was prior to the fracture. There was no pain, unusual weakness or swelling. He had no deformity. He was not afraid to bear full weight. He added, that, after hours of unusual strain, like a long walk over the hills and through the woods over rough ground, the knee would feel a little lazy and tired, but would fully recover in an hour.

Class—4?-4-4.

CASE 4. G. McB., male, aged 50 years. X-ray examination showed a comminuted, crushed fracture of the external tuberosity of the right tibia, with considerable widening of the joint surface and irregularity in contour. The posterior aspect of the external tuberosity was depressed. There was in addition, a comminuted fracture of the right humerus at the junction of the lower and middle thirds, with marked anterior bowing, but otherwise good position (Fig. 4a). Four and a half months after injury the patient walked with the aid of a cane. He had no limitation of motion, nor was there preternatural mobility.

Seven and a half months after fracture, there was good anatomic restoration, with a good symptomatic and economic recovery.

Class—4?–4–4.

CASE 16. J. B., female, aged 35 years. X-ray examination showed a comminuted fracture of the plateau of the internal tuberosity, of the left tibia, with the fragments in good position (Fig. 5). Approximately 2 years later she presented a complete recovery, with a good anatomical, symptomatic, and economic result. Approximately 5 years after fracture she stated that she had no discomfort or interference with function whatsoever. There was no deformity. She walked without a limp. She did not tend to favor that knee.

Class—4?–4–4.

CASE 17. A. R., male, aged 47 years. Ten months after injury the patient presented himself to the Surgical Out-Patient Department with the complaint of pain on walking. X-ray examination showed an oblique fracture of the upper end of the tibia, extending from the internal aspect of the shaft, upward to involve the articulating surface. There was a similar fracture of the upper end of the fibula. The fragments had united in good position (Fig. 6).

Class 4?–3–3.

CASE 25. M. S., female, aged 56 years. X-ray examination showed a comminuted, crushed fracture of the head of the tibia on the left side, with the fracture lines entering onto the joint surface. The fragments were in good position (Fig. 7).

In reply to a questionnaire, approximately 9 years after the fracture, the patient stated that the knee joint was completely ankylosed. A sequestra had been removed 4 years ago.

Class—0–2–3.

CASE 26. R. R., male, aged 33. X-ray examination showed a fracture of both tuberosities of the right tibia, with the fracture lines extending into the knee joint. The fragments were in good position (Fig. 8). At 3 months, and at 1 year after the fracture, the patient presented a good anatomical, symptomatic and economic result.

Class—4?–4–4.

CASE 27. C. G., male, aged 45 years. X-ray examination showed a crushed fracture of the tibial head, with the fragments in good position (Fig. 9a). In reply to a questionnaire about 10 years after injury, the patient stated that he was wearing a walking brace. There was no pain, weakness, or wobble, nor was he afraid to bear full weight. He limped, however, and there was a persistent bow of the injured knee.

Class—2–3–3.

CASE 32. R. C., male, aged 16 years. X-ray examination showed a fracture of the articular surface at the base of the inner tubercle of the spine. There was no displacement of the fragments (Fig. 10). Examination of the patient about 9 months after injury, showed a full anatomical, functional, and economic recovery. He stated that his knee joint was as strong as its fellow, as early as 2½ months after injury. He was not afraid to bear full weight on that knee, nor did he favor it when walking.

Class—4?–4–4.

CASE 35. W.C., male, aged 54 years. X-ray examination showed a comminuted fracture of both bones of the left leg, below the knee joint. There was a comminuted fracture of the internal condyle of the right femur, with the fragments in good position. There was, in addition, a comminuted fracture of the head of the right fibula, the fragments, likewise in good position (Fig. 11). At follow-up 4½ months after injury, he was able to walk without the aid of a cane or crutch. Examination about 5 months after the fracture, showed that flexion of the knee joint was limited to about 50 degrees. The joint was not as strong as it had been prior to injury. There was no pain, and the patient was not afraid to bear full weight upon it. He did not favor that joint when walking. There was no deformity. He observed occasional soft tissue swelling.

Class—4?–3–3.

CASE 36. F. P., male, aged 48 years. X-ray examination showed a longitudinal fracture of the lower end of the shaft of the left femur, with a splitting off of the external condyle. The fragments were in excellent position (Fig. 12). At follow-up, 6 months after injury, the patient presented a complete return of function. There was no deformity, weakness, pain or limitation of motion.

Class—4?–4–4.

BIBLIOGRAPHY

1. BARBILIAN, N. J. de Chir., 1926, xxviii, 663.
2. BERNARD, PAUL. J. Bone & Joint Surg., 1928, x, 509.
3. CARY, N. A. Calif. & West. Med., 1932, xxxvi, 226.
4. COLLINS, ARTHUR N. Minnesota Med., 1930, xiii, 285.
5. COTTON, F. J., and BERG, RICHARD. New England M. J., 1929, cci, 289.
6. CUBBINS, WILLIAM R., CONLEY, ARTHUR H., SEIFFERT, GARNET S. Surg., Gynec. & Obst., 1929, xlviii, 106.
7. CUTLER, C. W., JR. Ann. Surg., 1931, xciii, 3551.
8. CRILLOVICH, ROBERT. Arch. L. Orthopod., 1927, xxxv, 94.
9. KRIDA, A. Am. J. Surg., 1930, ix, 558.
10. NELSON'S LOOSE-LEAF LIVING SURGERY. New York: Thomas Nelson & Sons, 1929.
11. OLLERSHAW, ROBERT. Brit. J. Med., 1930, ii, 466.
12. STEUER, HERBERT, S. Ann. Surg., 1929, lxxxix, 580.
13. SWETT, PAUL P., MCPHERSON, S. H., and PIKE, M. M. Tr. New England Surg. Soc., 1930, xiii, 164.
14. WAGNER, LEWIS CLARK. Ann. Surg., 1930, viii, 623.

THE PATENCY OF BILIARY DUCTS

Determined By Radiopaque Oil Injected Through a T Tube Previously Placed in the Common Bile Duct for the Purpose of Prolonged Drainage

E. STARR JUDD, M.D., F.A.C.S., and J. ROBERTS PHILLIPS, M.D., Rochester, Minnesota
The Mayo Foundation

As has been pointed out, prolonged drainage of the biliary tract is advisable under certain conditions, such as removal of stones from the common bile duct, infection and suppuration in the biliary tract, and reconstruction of the duct over a T tube. Whenever the common bile duct is opened for any purpose, a tube should be left in the duct. If a T tube is employed, complete control of the flow of bile can be maintained; the bile may be allowed to discharge freely to the outside through the long arm of the T tube or it may be forced into the duodenum by clamping off the tube. In certain instances drainage by this method has been continued for as long as a year. We have not had the experience of having a stricture of the duct follow the procedure, and if the duct is patent there is no danger that a biliary fistula will persist after the tube is removed.

It is always desirable to know just what has taken place in the biliary tract and whether the ducts are patent, before removal of the tube is considered. From a clinical standpoint, this can be determined fairly accurately. One can be sure that the duct is patent if there is no discomfort in the upper part of the abdomen, no jaundice observed either clinically or by tests of serum, if the stools are of normal color, and if there is no leakage around the tube during the time that it is clamped off. However, in certain instances, although the ducts are wide open, only a small quantity of bile will be discharged. This is indicative of the degree of hepatic injury that has occurred. The jaundice will be slow to subside, and the stools will be slow to take on a normal color. Any measure that can be carried out that will give a better understanding of the whole situation will be advantageous.

In the past, visualization of the common bile duct was possible only occasionally, if there was a reflux into the biliary tract after an opaque meal. Sometimes other biliary radicals were seen. Venables and Briggs reported 2 cases of visualization of the biliary ducts after a barium meal. In 1 of these a stone in the common bile duct had trapped some barium above its level in the duct. In the other case there was obstruction high in the jejunum and medium was forced into the common bile duct, gall bladder, and some of the biliary radicals. Visualization has also been made possible by injecting medium through a tube placed in the gall bladder or in the stump of the cystic duct after cholecystectomy. Sometimes following the Graham-Cole test, both the gall bladder and the common bile duct are visualized.

A new method of studying the biliary tract was suggested to Gabriel by the publication of Ginsburg's and Benjamin's study of biliary fistula by the injection of lipiodol. Gabriel injected a radiopaque oil through the T tube that had been placed in the common bile duct for drainage. Overholt employed this method, and reported results in a series of cases. With this procedure, it is possible to prove definitely the patency of the ducts while the T tube is still in position. Sometimes the medium reaches the smaller biliary passages, and an opportunity is given to visualize these radicals and obtain a better understanding of the existent pathological processes.

We have used this method in 40 cases. The patient is placed under the fluoroscope and the radiopaque oil is injected; thus the passage of the medium through the biliary tract may be watched. It is not wise to carry out the procedure if patients have recently had chills or fever. The patients in our series have all been ambulatory; in no instance have injections been made earlier than 2 weeks after operation. Although the literature contains an occasional report of ill effects from the procedure, we have not had such experience. After the fluoroscopic examination, more of the medium is injected into the tract through the T tube, and a flat plate of the abdomen is made. In some cases we have used as much as 15 to 20 cubic centimeters of the solution.

If the liver has not been injured, and the common bile duct is not obstructed, the medium will flow into the duodenum so freely and so quickly that visualization of the biliary radicals is not possible. The following case is illustrative.

Case 1. A woman, aged 38 years, gave a history indicative of chronic cholecystic disease, existing for several years. Operation revealed chronic cholecystic disease without stones. The common bile duct was thick walled and

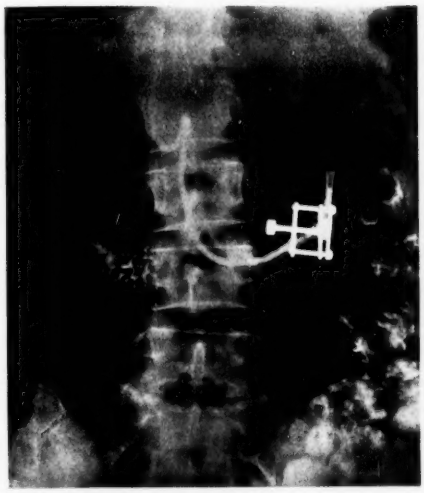


Fig. 1. Radiopaque oil injected through T tube which was placed in common bile duct 3 weeks previously. The distribution of this medium reveals that the ducts are patent.

Fig. 2. Radiopaque medium injected in dilated common bile duct, fills the duct; there is no medium in bowel. The biliary tract was drained by T tube for 6 months after removal of stones from the common bile duct.

about three times normal size. When it was opened, the bile appeared normal, but was under some tension. No calculi, but definite cholangitis was present. A T tube was inserted into the duct for the purpose of prolonged drainage of the biliary tract, and cholecystectomy was performed. The tube was left in place for 3 weeks, and before its removal, opaque medium was injected into the tract; this revealed that the ducts were patent, since the oil flowed freely into the duodenum, and there was no evidence of its presence in the biliary tree when a flat plate of the abdomen was made (Fig. 1).

If the function of the gall bladder has been completely destroyed by disease, there will usually be dilatation of the common bile duct and other biliary radicals. This may even be more manifest if there is also obstruction of the duct, such as is caused by stone. Insertion of the medium in these cases will show the dilatation of the duct and often some of the medium will reach the smaller biliary radicals. This is illustrated in the following case.

CASE 2. A man, aged 42 years, had had recurrent attacks of pain in the right upper quadrant of the abdomen for 20 years. Jaundice was sometimes present. A diagnosis was made of chronic cholecystitis with cholelithiasis and stone in the common bile duct. At operation it was found that the gall bladder was large and cystic, and that its function had been completely destroyed. The common bile duct was dilated and contained calculi. There was stony material in the ampulla of Vater. Cholecystectomy was performed and after removal of the débris from the common bile duct, a T tube was inserted for prolonged drainage; it was removed at the end of a month. After the patient had gone home he had two severe attacks of pain in the right upper quadrant of the abdomen without jaundice. Eight months later he returned because of further attacks. A second operation revealed that the common bile duct was thick walled and dilated to about four times normal size. The bile in the duct was under some tension. One large stone and several smaller ones were removed, after which a tube passed readily into the duodenum. A T tube was placed in the duct to insure free prolonged drainage. After it had been in place 6 months, radiopaque oil was injected through the T tube and the ducts were found to be markedly dilated, but patent. Some of the medium even entered the smaller biliary radicals. There had been no recurrence of symptoms, and no discomfort on clamping off the tube for as long as 24 to 48 hours. The patient felt that he was in good condition. We were certain that the ducts were patent, and that the opening in the duct would close promptly after removal of the tube. This proved to be the case (Fig. 2).

In 1 case the greater part of the biliary tree was well visualized, including some of the smaller radicals, yet there was no obstruction to the flow of the medium into the duodenum. The common bile duct was open. The wide dispersal of the medium through the biliary tree was undoubtedly made possible by the compensatory dilatation. Intermittent obstruction of the duct by stone over a period of years had undoubtedly increased the dilatation.

CASE 3. The patient, a man aged 34 years, had had severe colic in the right upper quadrant, associated with chills and jaundice, over a period of years. Two years before our examination, his gall bladder had been drained, with temporary relief of symptoms. One year later cholecystgastrostomy was performed without relief. During

Fig. 3. T tube drainage of common bile duct for 5 months following removal of stones; medium injected through T tube flows freely into duodenum; the biliary tree is well visualized.

Fig. 4. Common bile duct drained for 2 months with T tube, following removal of stones from the ampulla; injection of radiopaque medium revealed that duct is obstructed; lateral choledochoduodenostomy was necessary 19 months later.

this period he had become addicted to morphine because of continuance of the colic-like pain and the associated jaundice. A diagnosis was made of stone in the common bile duct. Exploration disclosed that the gall bladder was anastomosed to the stomach. The anastomosis was disconnected and the opening in the stomach closed. The common bile duct was then opened. It was filled with foul bile under tension, many small stones, and much mucus. After removal of the calculi, a curved forcep passed readily into the duodenum. A T tube was placed in the duct for prolonged drainage, and a dressed tube was stitched into the gall bladder. The liver was infected, and there was rather extensive enlargement in the head of the pancreas. Five and a half months after this operation, the patient returned. He was in good condition. There was no external drainage through the long arm of the tube, no jaundice, and stools were of normal color. The ducts were studied by injection of the opaque medium and found to be patent. The tube was then removed from the duct without difficulty. There was slight drainage of bile afterward, but the patient was able to start for home the following day. He reports that he has remained well (Fig. 3).

Should discomfort arise on clamping off the external branch of the T tube, or should jaundice increase, one can be reasonably certain that there is some obstruction in the duct. The use of radiopaque oil will disclose the condition, which is illustrated by the following case.

CASE 4. A man, aged 62 years, had had cholecystectomy performed in 1930 because of cholecystic disease with stones. He came to the clinic 7 months later with an external biliary fistula and obstructive jaundice, which was due to a stone in the common bile duct. In spite of the drainage of bile to the outside, the jaundice had persisted. At operation, it was found that the liver was slightly atrophic. The common bile duct was tremendously dilated and easily admitted the first finger. Stony material was removed from the ampulla of Vater. There was some inflammation in the tissues at the lower end of the common bile duct. The head of the pancreas was enlarged. The right hepatic duct was not seen. A T tube was inserted into the common bile duct with the idea that it was to remain until the jaundice subsided. It was thought at the time that lateral anastomosis between the common bile duct and the duodenum might be necessary later. However, we were sure the duct was open at times, since bile was recovered from the duodenal contents. Injection of the opaque medium through the T tube showed that the duct was tremendously dilated.

The T tube was removed 2 months after its insertion. The fistula gradually closed. Nineteen months after removal of the tube, lateral anastomosis between the duodenum and the common bile duct was necessary on account of jaundice and colic. Posterior gastro-enterostomy was made at the same time, because of impending duodenal obstruction (Fig. 4).

CONCLUSIONS

We feel that this method of determining the patency of the common bile duct affords a better understanding of postoperative conditions in the biliary tract which have necessitated drainage by the T tube. Should obstruction exist, its extent can often be ascertained. If the ducts are found to be patent, it may be assumed that there will be no external drainage on removal of the tube. The knowledge concerning individual cases will be

more complete, and the final results can be more definitely estimated.

BIBLIOGRAPHY

1. GABRIEL, W. B. Proof of patency of the common bile-duct by the injection of lipiodol. Lancet, 1930, i, 1014–1015.
2. GINSBURG, LEON, and BENJAMIN, E. W. Lipiodol studies of postoperative biliary fistula. Ann. Surg., 1930, xci, 233–241.
3. OVERHOLT, R. H. Biliary tract visualization with radiopaque oils. Surg., Gynec. & Obst., 1931, lii, 92–97.
4. VENABLES, J. F., and BRIGGS, P. J. Visualization of the bile ducts after an opaque meal. Guy's Hosp. Rep., 1929, lxxix, 123–126.

CARCINOMA OF THE CERVIX UTERI

FIVE YEAR RESULTS OF RADIUM TREATMENT

LAWRENCE A. POMEROY, M.D., F.A.C.S., CLEVELAND, OHIO

From the Tumor Clinic, City Hospital, the Department of Gynecology, Lakeside Hospital, and the Department of Radium Therapy, St. Alexis Hospital

THE recent request of the American College of Surgeons for details of the results in cases of malignant disease treated in 1924–25–26 furnished the occasion for this series of cases. This report deals with 79 cases of carcinoma cervix uteri treated by me with radium during the years 1924–25–26, all of which were proved by histological examination of biopsy specimens.

CLINICAL RECORD

The histories recorded in these cases showed the usual complaints of vaginal bleeding, vaginal discharge, and occasionally some pain. The age incidence, however, was of some interest. The greatest number of cases, as is usual, occurred between the ages of 41 and 55 years. The youngest patient treated was 26 years, there being 3 of this age. The youngest 5 year cure was 37 years of age, there being 3 of this age. The figures regarding the number of pregnancies were not remarkable except that 10 per cent of the patients had never been pregnant. This percentage was almost identical with that reported by me (3) in an earlier series of cases.

A special effort was made to determine the delay in consulting a physician, the responsibility for such a delay being the patient's; and the delay in satisfactory treatment after a physician's advice, this delay being at times the responsibility of the patient and at times that of the physician. The average delay in consultation was 2.6 months. The shortest total delay was 3 days and the longest total delay 3 years, the average total delay for the entire series being 8 months. This last figure is particularly interesting as the average total delay for the 5 year cures was 4.8 months. These figures emphasize the necessity for prompt treatment if permanent cures are to be obtained.

EXAMINATION

These cases were classified according to the original classification used by the American College of Surgeons: (1) primary case; (2) recurrence in vaginal wall following panhysterectomy for cancer; (3) recurrence deep in pelvis following panhysterectomy; (4) carcinoma of cervix following supracervical hysterectomy.

(A) Disease limited to cervix; (B) disease involving uterine cavity or vaginal wall; (C) disease involving broad ligaments; (D) wide fixation, remote metastases.

Most of our cases were classified as 1 B.C., involvement both of the vaginal wall and broad ligaments being present in most of them. In addition a + or − was added to this classification, + meaning a proliferative and − a destructive growth. A typical + case was a papillary growth filling the upper vagina. A typical − case was crater formation with no projecting cervix. These extremes were easy to classify but all cases, even those where proliferation or destruction was not marked, have been classified, according to the opinion of the operator at the time of treatment, as either + or −.

DETAILS OF TREATMENT

Glass seeds were used for all implantations and X-ray was used to supplement the radium only in 9 of the 79 cases. This technique has now been

changed by using gold radon implants and usually by the addition of X-ray treatment after the radium treatment, but the figures given are based on the old method of treatment. A typical radium treatment consisted of one 75 milligram tube, screened with 0.5 millimeter silver, 1 millimeter brass, and 1.5 millimeters rubber or aluminum, applied within the cervical and uterine canals for 36 hours, making a dosage of 75 × 36 equals 2700 milligram hours. In addition the cervix was implanted with 12, 1 millicurie glass implants of radon making an additional dosage of 12 × 1 × 132 equals 1584 millicurie hours or a total dosage of 2700 + 1584 equals 4284 milligram and millicurie hours or 32.45 millicuries destroyed. The maximum dosage was 10,464 milligram hours, the average dosage being 4287 milligram hours, corresponding very closely to the typical dose given above. The largest dose in the series of 5 year cures was 7248 milligram hours, the average dose being 4428 milligram hours.

Seventy-seven and two-tenths per cent of the patients received one radium treatment, 16.5 per cent received two radium treatments, and 6.3 per cent received three treatments. Of the 5 year cures 76.9 per cent received one treatment, 23.1 per cent two treatments, there being no 5 year cures among the patients receiving three treatments. I believe that it is useless to try to accomplish too much by increasing the radium dosage.

COMPLICATIONS

Of the complications following treatment the development of fistula alone has been analyzed. Two patients developed rectovaginal fistulæ and 4 developed vesicovaginal fistulæ. One patient developed both rectovaginal and vesicovaginal fistulæ. This patient, however, had diabetes which may have been a factor in causing excessive necrosis after irradiation. Three of the vesicovaginal fistulæ developed in patients where the tumor was originally classified as 1 D. −, primary cervical growth with wide fixation and crater formation. In all of these the pre-operative examination showed rather marked involvement of the bladder wall and the fistula was probably an inevitable complication independent of the treatment, as these patients each received a single small dose of radium. The two rectovaginal fistulæ occurred in patients where the growth was classified as 1 B.C. +. In both of these three radium treatments had been given in the endeavor to control a bulky growth which would not respond well to treatment. In these cases the repeated irradiation may have been a cause of the fistula.

RESULTS

An effort was made to establish some connection between the + and − classification and prognosis. The average duration of bleeding control in the + cases was 30.4 months, and in the − cases 18.9 months. The average duration of life after treatment in + cases was 35.5 months and in − cases 21.4 months. Eight of 13, 5 year cures were classified as + and 5 as −. This would seem to indicate a better prognosis in the + cases.

Of the 13, 5 year cures 3 were classified as 1 A., 6 as 1 B.C., 1 as 1 D., 1 as 2 B., 1 as 4 B., and 1 as 4 B.C. There were 3, 5 year cures among 5 patients classified as 1 A., the definitely operable group in the old statistics.

The 5 year cures for each year were as follows: 1924 series (17 patients, 1 cure) 5.8 per cent; 1925 series (25 patients, 4 cures) 16 per cent; 1926 series (37 patients, 8 cures) 21.6 per cent. This gives 16.4 per cent of 5 year cures for the entire series of seventy-nine cases. In computing these percentages all untraced patients were included and counted as dead.

HISTOLOGICAL CLASSIFICATION

[1]Histological grading of the entire group was made according to the criteria of Martzloff. In 69 instances the grading was made directly from the microscopic sections and in 10 instances, in which the sections were not available, the microscopic descriptions were deemed adequate for grading. In applying the criteria of Martzloff it was recognized that there was a certain degree of overlapping of the groups and in such cases the dominant cell type determined the group. Group I was comprised not only of tumors which were keratinizing and tumors containing prickle cells, but also all of those in which the cells resembled those of the upper layers of cervical epithelium. Group II consisted essentially of transitional cell tumors, although many of them were more or less differential in certain portions. Group III included undifferentiated tumors, many of which were composed of spindle cells, while others were so completely anaplastic as to be best characterized as carcinoma simplex. Adenocarcinomata were grouped separately but were not given a group number.

CONCLUSIONS

Table I shows the total delay in treatment, the duration of bleeding control and the duration of life after treatment in all cases classified according to the cell differentiation.

[1]I am indebted to Dr. Alan R. Moritz of the Institute of Pathology of Western Reserve University for the histological grading of these tumors.

TABLE I

Cell group	Cases	Delay months	Bleeding control months	Life months
Well differentiated....	23	6	24	32
Partially differentiated	38	8	19	20
Undifferentiated.....	13	9	23	25
Adenocarcinoma.....	5	10	43	48

Table II shows the 5 year cures grouped according to the cell differentiation.

TABLE II

Cell group	Cases	No. of 5 year cures	Per cent of 5 year cures
Well differentiated.....	23	4	17.3
Partially differentiated.....	38	5	13.1
Undifferentiated.....	13	2	15.3
Adenocarcinoma.....	5	2	40.0

It must be borne in mind that the variation in group survival is not alone an index of the inherent malignancy of the histological types, but also an index as to their susceptibility to radium. According to Martzloff the undifferentiated cells compose what is inherently the most malignant group and his follow up records indicate that to be true in cases treated surgically. Healy and Cutler however, show much better results in advanced cases of the undifferentiated cell group than in advanced cases of the well differentiated cell group where the patients were treated by irradiation.

SUMMARY

1. In a series of 79 cases no 5 year cures were obtained in patients below the age of 37 years.

2. The average total delay before treatment was 4.8 months in the 5 year cures, contrasting with 8 months in the entire series.

3. The gross examination was the greatest single aid in estimating the prognosis, extremely good results being obtained in cases where the disease was limited to the cervix, the diagnosis being made early and treatment started promptly.

4. The proliferative tumors gave better results than the destructive tumors, as to duration of bleeding control, duration of life, and percentage of 5 year cures.

5. The 5 year cures by years were as follows: 1924, 5.8 per cent; 1925, 16 per cent; 1926, 21.6 per cent.

6. The degree of cell differentiation seems to have little influence on the percentage of 5 year cures obtained in each group. However, the best results, 2, 5 year cures among 5 patients treated, were obtained in the adenocarcinomata.

REFERENCES

1. Healy, William P., and Cutler, Max. Relation between structure and prognosis in cervical carcinoma under radiation treatment. Am. J. Obst. & Gynec., 1928, xvi, 15–28.

2. Martzloff, K. H. Carcinoma of cervix uteri; pathological and clinical study with particular reference to relative malignancy of neoplastic process as indicated by predominant type of cancer cell. Johns Hopkins Hosp. Bull., 1923, xxxiv, 141–149; 184–195.

3. Pomeroy, Lawrence A. Five-year end results of radium treatment in carcinoma of the cervix uteri. Am. J. Roentgenol., 1927, xviii, 514–519.

EARLY RECOGNITION OF ILIOPECTINEAL BURSITIS

DENIS S. O'CONNOR, M.D., F.A.C.S., NEW HAVEN, CONNECTICUT
Assistant Professor of Orthopædic Surgery, Yale University School of Medicine

ILIOPSOAS or more properly iliopectineal bursitis has been recognized since 1834 (13). At least, medical history recorded its recognition at that time. In 1925, when a survey of the literature on this subject was made by Gatch and Green, only 33 cases had been recorded. Since 1925, 4 additionl cases have been reported. It would seem, therefore, that the condition is of infrequent occurrence, but a consideration of the reported cases in the light of our knowledge concerning bursæ, forces one to the belief that the reported cases represent only those lesions of the iliopectineal bursa which had progressed to a point where surgical measures were deemed necessary as treatment and, incidentally, made the recognition of the condition possible.

The length of time for which the symptoms of the condition existed before the correct diagnosis was made (2) is, in itself, an indication that the condition may exist unrecognized for many years.

The desirability of early recognition of the lesion when it is present is important for several reasons. The proximity of the iliopectineal bursa to the hip joint and the symptoms common to lesions in both the bursa and the joint render a correct diagnosis desirable, if not imperative, when the question of surgical interference arises. The proximity of the iliopectineal bursa to the inguinal and femoral rings undoubtedly has resulted in many herniotomy operations on a faulty diagnosis with failure to relieve the symptoms.

The condition is intractable under the most intelligent treatment and, if undiagnosed, is most unlikely to receive adequate treatment. Then, too, in the field of traumatic surgery, in which field most of the lesions of this bursa may be found, prognosis is important and an intelligent prognosis cannot be given if the true lesion is not recognized.

HISTORICAL

The first case of iliopectineal bursitis reported was from Germany by Fricke in 1834. The patient was a carter and the pain was referred to the knee. In 1847, Joly reported a case and wrote what is still one of the outstanding papers on this condition. The right diagnosis was made in this case before operation. In 1859, Chassaignac reported a case in which cure was obtained by injection of equal parts of water and iodine. In 1868, Heineke reported the first case in a female and noted that active motion of the hip was limited and weak, while passive motion was free and painless. An additional case was added in 1873 by Rose. In 1880, Charleston removed a cyst which extended from within the pelvis down to the knee. The extent of this cyst has caused some writers to exclude this case from the series. In the same year Schaeffer reported a case which seemed to have its origin in an injury 2 years previously. Prengrueber in 1885 reported a case, the tumor mass of which interfered with motion in the hip, caused pain along the course of the anterior crural nerve, and extended up beneath Poupart's ligament. In the same year, Baker reported a case having symptoms for 9 years. In 1887, Sprengel reported a case in which the bursa communicated with the hip joint. Two years later, Hoffa reported a case in which the limb was in partial flexion, slightly abducted and externally rotated. Motion in the opposite directions was limited and painful. Mondain, about the same time, pointed out the communication between the bursa and the hip joint. In 1891, Dagron reported Le Dentin's case in which infection developed and extended to the hip joint through a communication, causing the death of the patient. Sonneborn added a case in 1894 and the following year, Durville, in a study of the condition, pointed out that weakness of the limb might be a symptom of the condition and that the referred pain to the knee was due to the relation of the enlarged bursa to the anterior crural nerve. Mommsen, about the same time, reported 2 cases in 1 of which the femoral artery was pushed forward. Zuelzer, writing on "Diseases of the Bursæ of the Hip" in 1899, gave injury as the etiology in the majority of cases and regarded syphilis and rheumatism as contributing factors. De Weck and Duprez in 1900 found an enlarged bursa containing several chondro-osseous bodies. Delbet reported similar findings in 1902. Lund reported 3 cases in the same year and gave the results of his study of the bursa in 18 cadavers. He found the bursa to extend up over the brim of the pelvis in 50 per cent of the specimens examined. Cullen, in 1910, found cartilaginous plaques in the wall of a cyst which was very large and occupied a large space in the abdomen. Pisano, in 1913, found his specimen to have an endothelial lining.

Kummer found œdema and varices as a result of the pressure of the tumor on the venous trunk in front of the hip. In 1925, Gatch and Green collected 32 cases from the literature and added 1 case. They found 23 of the 32 to be of the traumatic or non-infectious variety. They classified the cases as pyogenic, tuberculous, syphilitic, and cystic. They further pointed out that symptoms may be present for years before the appearance of a tumor. Additional cases were reported by Ehrlich; by Chastenet de Gery in 1928; and by Sorrel and by Hammesfahr in 1929. Volkmann, Maissoneuve, Couteaud, Hardtman, Auray, Wood and Ehrle have reported cases as well.

ANATOMY

The bursæ are not regarded in the fields of medicine and surgery as of any great importance, and they are in reality comparatively unimportant from a purely anatomical or surgical viewpoint.

From an economic viewpoint, and in spite of us that viewpoint is acquiring greater and greater force in medicine, the bursæ are important because lesions of bursæ give rise to pain, the bursæ are most commonly contiguous, and indispensably related, to joint motion and the proneness of bursal lesions to chronicity renders them a potential factor for prolonged disablement unless promptly recognized and adequately treated.

One who has suffered from a lesion of the subacromial bursa will, I am sure, hold that bursa in a respect entirely out of proportion to its size or comparative surgical importance.

The following case illustrates the failure of the profession to recognize iliopectineal bursitis and the prolonged disability:

J. J. H., aged 32 years, pressman, was referred to me on January 13, 1929, with a complaint of pain in the right thigh of about 5 years' duration. The onset was sudden, immediately following an incident while at work. He was standing near a printing press with his right foot on the step of the press and was bearing forward to get a "form" which was being passed up to him from a lower level when his foot slipped off the step, straining the front of the right hip. The pain was sufficiently severe to cause the patient to consult a physician the same day. The physician could find nothing on physical examination and had a roentgenogram of the hip which was entirely negative. The patient was disabled for 1 week and returned to his employment but was conscious of some remaining difficulty in the region of the hip. Following this injury, the patient was disabled for several days at a time at irregular intervals because of a recurrence of the trouble. The pain complained of originated in the front of the right hip and radiated down to the knee cap. The patient noticed that the leg was "clumsy" and dragged, causing him to stumble when he was tired.

The patient consulted various regular and irregular practitioners of medicine and used many forms of treatment without relief.

Examination disclosed a point of tenderness just below Poupart's ligament about midway between the anterior superior spine of the ilium and the symphysis pubis and just lateral to the femoral pulsation. The thigh was held in external rotation and slight adduction. Internal rotation and abduction were limited and painful. Hyperextension of the body on the hip and hyperextension of the right hip on the body caused pain in front of the hip radiating down to the knee. The right thigh showed 1 inch atrophy in circumference. The psoas muscle power was markedly weakened. The blood findings were normal. The roentgenograms were normal. A diagnosis of chronic, non-infectious iliopectineal bursitis was made and the patient treated by rest and heat to the hip with eventual complete relief of symptoms.

A surgeon who has had occasion to treat many lesions of the subacromial bursa does not depend too greatly upon a beneficent nature for a favorable result.

The work of Codman in bringing the subacromial bursa into prominence is even today not too well known nor too greatly appreciated. The iliopectineal bursa, in which we are interested at this time, has been spoken of by Osgood as the largest bursa in the body. Apparently, it varies in size between wide limits. Even the fact that the bursa exists is not too well known, and a brief description of it at this time seems desirable. According to Joessel, the iliopsoas bursa, or the bursa mucosa subiliaca, lies between the partly tendinous portion of the iliac muscle and the front of the iliopectineal eminence. Anteriorly, it is firmly attached to the iliopsoas muscle, posteriorly to the pectineal eminence, and likewise to the thin portion of the capsule of the hip joint. It is bounded on the outer side by the iliofemoral ligament, below by the pubofemoral ligament, and on the inner side by the cotyloid ligament. Occasionally, the fibrous capsule at the thin point is lacking and again the synovial membrane may be lacking, so that there is direct communication between the bursa and the joint.

In 1927 Kessel published an unusually complete anatomical study of this bursa which is well worth reading in the original publication. He concluded that the bursa appeared early in life, and proved that it was present in an embryo of 25.75 millimeters.

With reference to the communication between the hip joint and the bursa, he found the communication existing in 15 per cent of 535 adult anatomical specimens. The existence or nonexistence of the communication between the hip joint and the bursa is of great surgical importance. In aspiration of the hip joint, the point for the introduction of the needle corresponds to that

SUMMARY OF CASES

Name Age	Occupation	Symptoms			Signs				Pain on		Side affected	Tentative diagnosis	Treatment	Result	Ascribed cause
		Pain	Weakness	Swelling	Tumor	Fluctuation	Limitation	Tenderness	Active motion	Passive motion					
F.H. 32	Pressman	P.	P.	P.	N.	N.	N.	P.	P.	P.	R.	Bursitis	Rest	Relieved	Sprain of hip
R.DeM 40	Laborer	P.	P.	N.	N.	N.	N.	P.	P.	P.	L.	Bursitis	Rest—heat	Relieved	Lifting
M.M. 42	Laborer	P.	P.	N.	N.	N.	N.	P.	P.	P.	L.	Bursitis	Rest—heat	Relieved	Strain of hip
J.S. 71	None	P.	P.	N.	N.	N.	N.	P.	P.	P.	L.	Bursitis	Rest—heat	Relieved	Focal infection
A.B. 17	Student	P.	?	P.	P.	P.	N.	P.	P.	P.	R.	Septic hip	Incision and drainage of hip	Ankylosed hip	Gymnasium work
V.B. 19	Student	P.	P.	N.	N.	N.	N.	P.	P.	N.	R.	Bursitis	Rest—muscle training	Relieved	Automobile collision
C.D. 27	Maid	P.	P.	N.	N.	N.	N.	P.	P.	N.	R.	Hernia	Rest	Partially relieved	
J.D. 62	Press Opr.	P.	P.	P.	P.	N.	P.	P.	P.	P.	R.	Osteitis of ilium	Not treated		Press operation
M.D. 45	Laborer	P.	P.	P.	P.	P.	P.	P.	P.	P.	R.	Psoas abscess	Incision and drainage	Recovery; good result	Lifting strain
A.M. 57	Cobbler	P.	P.	P.	P.	P.	P.	P.	P.	P.	R.	Bursitis	Incision and drainage	Recovery; good result	Hip strain
M.C. 20	Press Oper.	P.	P.	P.	N.	N.	N.	P.	?	?	R.	Bursitis	Not treated		Struck by automobile
G.S. 60	Watchman	P.	P.	N.	P.	N.	P.	P.	P.	N.	R.	Bursitis	Rest	Relieved	Osteo-arthritis
H.G. 35	None	P.	P.	N.	P.	N.	P.	P.	P.	P.	R.	Bursitis	Rest	Improved	Spondylitis rhizomelica
M.W. 63	Housewife	P.	P.	N.	N.	N.	N.	P.	P.	N.	R.	Bursitis	Rest	Relieved	Osteo-arthritis
K.P. 30	Housewife	P.	P.	N.	N.	N.	N.	P.	?	P.	R.	Bursitis	Rest	Relieved	Unknown
D.P. 48	Moulder	P.	P.	N.	N.	N.	P.	P.	P.	P.	L.	Bursitis	Rest	Relieved	Strained use of leg
M.L. 42	Laborer	P.	?	N.	N.	N.	P.	P.	P.	P.	L.	Bursitis	Rest—heat	Cleared up	Strain of leg
S.C. 20	Student	P.	P.	N.	N.	N.	P.	P.	P.	P.	R.	Bursitis	Rest—heat	Cleared up	Kicking football
M.D. 60	Housewife	P.	P.	N.	N.	N.	P.	P.	P.	P.	L.	Bursitis	Rest—heat	Relieved	Osteo-arthritis
J.L. 8	Student	P.	?	N.	N.	N.	P.	P.	P.	P.	R.	Psoas spasm	Traction	Relieved	Hip strain from splint
J.S. 16	Student	P.	P.	N.	N.	N.	P.	P.	P.	P.	L.	Tbc. hip	Arthrodesis	Bad	Strain of hip getting off horse
R.T. 38	Truck Helper	P.	P.	N.	N.	N.	P.	P.	P.	P.	R.	Iliopectineal bursitis	Rest	Improved	Lifting heavy box
B.W. 52	Brass Caster	P.	P.	N.	N.	N.	P.	P.	P.	P.	L.	Luetic arthritis	Rest	Cured	Bowling
M.K. 19	Clerk	P.	P.	N.	N.	N.	P.	P.	P.	P.	L.	Iliopectineal bursitis	Rest	Improved	Lifting box
A.C.B. 19	Student	P.	P.	N.	N.	N.	P.	P.	P.	P.	L.	Iliopectineal bursitis	Rest	Improved	Springing from crouch pos.
W.F. 70	Laborer	P.	P.	P.	P.	P.	P.	P.	P.	P.	L.	Infectious iliopectineal bursitis	Incision and drainage	Cured	Old ununited fracture of neck of femur

SUMMARY OF CASES—Continued

Name Age	Occupation	Symptoms			Signs				Pain on		Side affected	Tentative diagnosis	Treatment	Result	Ascribed cause
		Pain	Weakness	Swelling	Tumor	Fluctuation	Limitation	Tenderness	Active motion	Passive motion					
H.M. 61	None	P.	P.	P.	P.	P.	P.	P.	P.	P.	R.	Infectious iliopectineal bursitis	Incision and drainage	Died	None
P.R. 31	None	P.	P.	P.	P.	P.	P.	P.	P.	P.	L.	Tbc. hip	Incision and drainage	Relieved	None
G.P.W. 19	Student	P.	P.	N.	N.	N.	P.	P.	P.	P.	L.	Iliopectineal bursitis	Rest	Improved	Football
E.U. 20	Student	P.	P.	N.	N.	N.	P.	P.	P.	P.	R.	Iliopectineal bursitis	Rest	Improved	Football
W.R.S. 18	Student	P.	P.	N.	N.	N.	P.	P.	P.	P.	R.	Iliopectineal bursitis	Rest	Improved	Rowing
L.G. 54	Laborer	P.	P.	N.	N.	N.	P.	P.	P.	P.	L.	Iliopectineal bursitis	Rest	Improved	Unknown
L.E. 75	None	P.	P.	P.	P.	N.	P.	P.	P.	P.	L.	Iliopectineal bursitis	Rest	Improved	Osteo-arthritis

P., Positive. N., Negative.

point on the anterior aspect of the hip at which the bursa is nearest the surface. The thin point in the joint capsule lies directly through the bursa. If no communication existed between the bursa and the hip joint, infection in the bursa would most certainly be carried into the hip joint by the aspirating needle. Then again, with no communication between the bursa and the joint, if the existence of this bursa were not recognized and pus obtained from aspiration of the bursa, an operation on the hip joint would most likely result in the infection of the hip joint with all the tragic results of such an infection. The following case from the author's series will illustrate this surgical tragedy very vividly:

A girl of eighteen years, a student in a school of physical education, "strained" her right hip in straddling a "buck." She was conscious of some discomfort in the hip but did not regard it as of any importance. Shortly afterward, she contracted a severe epidemic "cold" which, after a few days, seemed to have settled in the "strained" hip. The pain in the hip became very much worse, the hip could not be extended because of pain, the patient's temperature arose to 104 degrees F., and all the signs of a severe toxæmia were present. The physicians in attendance were unable to find anything except the hip condition to account for the severe toxæmia and a surgeon was called in consultation. The surgeon, while not fully satisfied with his findings, because of the difficulties of examining a very ill patient, concluded that the hip joint was the site of a purulent infection and opened the hip joint through an Ober incision on the posterior aspect of the joint. To his surprise, the hip joint showed no evidence of infection except for a small amount of fibrin. The patient was returned to bed and traction was applied to the affected leg. On recovering from the anæsthetic, the patient complained bitterly of pain and more weight was added to the traction in the belief that the amount of weight was insufficient. The pain, however, became greater with the increasing weight, a rather unusual situation in hip joint disease. The temperature and other signs of severe toxæmia, present before operation, persisted unabated. Several days later, the patient was again operated upon, the incision being made in the front of the hip region. When the soft tissues, corresponding to the site of the iliopectineal bursa, were cut into a large amount of bright yellow pus was released. Still not realizing the true location of the lesion, the surgeon continued his incision into the hip joint to get through-and-through drainage. The pain and other symptoms gradually receded. The patient ultimately recovered with an ankylosed hip.

From the clinical course of this case, it is evident that the lesion causing the toxic symptoms was an acute purulent iliopectineal bursitis. Had the surgeon made a correct diagnosis, the patient probably would not have an ankylosed hip and ruined career today.

SEX

A series of 33 cases which have been seen by the author are presented here and analyzed. In this series 11, or one-third of the subjects, were female and two-thirds of them were male. The preponderance of males is not surprising, the real surprise being the high percentage of females affected, since violent muscular activity is a prominent factor in the etiology of the condition in most cases. This high percentage of females who have been affected might be explained by the tendency on the part of the women of today

to recognize no activity from which they are barred because of their sex.

AGE

The series is classified according to the decade of age in which the cases fall:

	Cases	Totals	Per cent
1 to 10	1		
11 to 20	10	11	33⅓
21 to 30	2		
31 to 40	5		
41 to 50	4	11	33⅓
51 to 60	5		
61 to 70	4		
71 to 80	2	11	33⅓

Several interesting facts may be gleaned from the distribution of cases according to age. In the 1 case observed in the first decade of life, the patient was afflicted with anterior poliomyelitis with residual paralysis involving one of the lower extremities. A long leg brace, applied to the extremity to prevent deformity, caused an irritation of the bursa by the force necessary to bring the extremity forward in walking. The second decade of life with 10 cases was twice as great as any other single decade. This frequency of involvement in youth is explained by the participation of young people in vigorous out-of-door sports.

During the age period of 21 to 50, the period of adult life of greatest activity in industry, 11 cases, or 33⅓ per cent of the cases were observed.

During the age period from 51 to 80, the other third of the cases was observed and, while industrial activity would account for some cases, another factor, hypertrophic changes about the hip joint, enters to be a causative factor.

So, it might be said, that in youth, participation in sports is a prominent etiological factor; in early and middle adult life, occupational activities of a vigorous nature are a factor; and, late in life, bony hypertrophy about the hip joint is a factor.

OCCUPATION

While the causative factors in the production of iliopectineal bursitis were not in all cases connected with the patient's occupation, a sufficiently large number of them occurred in the course of the patient's employment and the occupation was obtained in all cases. The importance of iliopectineal bursitis as a compensable injury has not been recognized due to the unfamiliarity of the profession with this condition. At least, 4 of the cases in this series were compensated on the basis of the correct diagnosis.

Occupation	Cases
Student	9
Laborer	7
Housewife	4
Press operator	2
Pressman	1
Cobbler	1
Molder	1
Brass caster	1
Truck helper	1
Watchman	1
Clerk	1
No occupation	4
	33

ASCRIBED CAUSES

The sudden onset of symptoms and the violent nature of the trauma liable to cause the condition operated to make the probable cause of the condition fairly clear:

Cause	Cases
Violent hyperextension of hip	8
Lifting	4
Secondary to malum coxæ senilis	5
Occupational acts	2
Kicking football	3
Bowling	1
Rowing	1
Coasting	1
Automobile collision	1
Struck by automobile	1
Secondary to poker spine	1
Unknown	2

In 19 cases the cause was sudden muscular action involving the psoas muscle while the thigh was flexed on the body or the body was flexed on the thigh. This is an important observation. If the anatomical peculiarities of the iliopectineal bursa be realized, the explanation is obvious. The bursa is in front of the hip joint and attached posteriorly to the anterior part of the joint capsule. In front of the bursa is the tendon of the psoas to which the bursa is also attached. When the thigh is flexed on the body or the body on the thigh, the psoas tendon tends to ride away from the front of the hip joint. In this position the bursa is stretched between the capsule of the hip joint and the tendon of the psoas. Sudden violent action on the psoas causes violent stretching of the bursa, a trauma which initiates the pathological changes in the bursa. Continued use of the traumatized bursa results in the changes in the bursa common to all bursæ. Six cases were secondary to hip joint disease or spine disease which interfered with the normal function of the hip.

Type. Five cases were infectious. In the infectious cases, trauma may still be a factor with infection elsewhere in the body complicating what might otherwise be a cystic type of lesion. Twenty-eight cases were cystic or non-infectious.

Results. One person died from the septicæmia which was associated with, but not secondary to, the bursitis. All the other cases recovered although those associated with malum coxæ senilis and poker spine could be considered only temporary and recurrence should be expected.

One case in which the hip joint was opened in the presence of the infection in the bursa recovered with an ankylosis of the hip. Another patient, who was operated upon with a diagnosis of tuberculosis of the hip, unconfirmed by roentgenological examination, recovered with an ankylosed hip. The subsequent examination of tissue removed at the time of operation showed no evidence of tuberculosis. The symptoms in the patient came on immediately after the patient had "strained" the hip while dismounting from a horse and had existed only a few weeks when the operation was performed.

Four cases of the infectious type were treated by incision and drainage with ultimate recovery although drainage persisted for several months, a not unusual condition in any infected bursa.

Symptoms. Pain was the outstanding symptom in every case. Pain is really of two types: the pain of bursal irritation and the pain referred to the front of the knee and thigh from contiguous irritation of the femoral nerve. Weakness in the extremity affected was a positive complaint in all but four cases.

Swelling of the front of the hip region was complained of in 10 cases.

Signs. Every patient on examination showed tenderness on pressure over the small area in front of the upper end of the thigh, just below Poupart's ligament and about midway between the anterior superior spine of the ilium and the symphysis pubis. This area is lateral to the femoral artery and medial to the femoral nerve. In size, it is not more than 2 centimeters in diameter. In the late stages of the condition, this area is considerably larger. All but 2 patients had pain on active motion of the hip especially in those directions in which the bursa was pressed upon or pulled upon. Six patients did not show pain on passive motions of the hip. Limitation of motion of the hip in abduction, with internal rotation and hyperextension was present in all but 2 cases. Fluctuation was elicited in 6 cases, 5 of which were of the infectious type. Tumor or swelling was present in 10 cases. The right bursa was affected in 18 cases. The tentative diagnosis was right in 25 of the 33 cases. Twenty-four cases, treated by rest and heat, were relieved and no recurrences have been reported.

Fig. 1. Schematic drawing from Whitman's *Orthopædic Surgery* of the psoas muscle origin and insertion, showing the muscle riding away from the hip joint in flexion of the hip.

THE EARLY CONCEPTION OF THE CONDITION

The purpose of this paper is to bring to the attention of the medical profession iliopectineal bursitis in its early stages as a common condition. The relatively large number of cases seen by the author within a 4 year period, all of which correspond rather closely in signs, symptoms, and clinical course; most of which had been seen by many other surgeons who were unable to make any diagnosis and who failed to relieve the condition, many of whom were relieved by the measures predicated upon the diagnosis of bursitis, suggests at least that it represents a common condition. Some of the cases presented herewith were seen before the author was ever aware that the iliopectineal bursa existed and were classified as undiagnosed in his files. All have been considered carefully from a diagnostic standpoint and several cases have been omitted from this series because other conditions could not be ruled out or the findings, while suggestive, were not conclusive enough to warrant the diagnosis of iliopectineal bursitis.

A typical case report of the iliopectineal bursitis is given here in order that one may understand the dynamic pathology of the condition.

J. D., a 65 year old female press operator, was seen in consultation on November 12, 1926, for a complaint of pain in the right hip region of 3 years' duration. The patient had worked as a press operator for over 20 years and shortly before the onset of symptoms had been obliged to change from a press in which the motion of the right leg was a forward swing to one in which the foot lever was pushed downward. She ascribed her hip pain to the change in the operation of the press. The pain complained of radiated to the knee. The hip was "stiff" in the morning on arising but gradually became less stiff after some activity. The pain, however, was greatest at the end of the day after activity and was better on holidays when patient did not work. For a time, the patient was able to continue her regular work but about a year previous to this examination she had to give up all work because of the pain.

The patient appeared to be in good general condition for a person of her years and social status. The general physical examination developed no noteworthy defects.

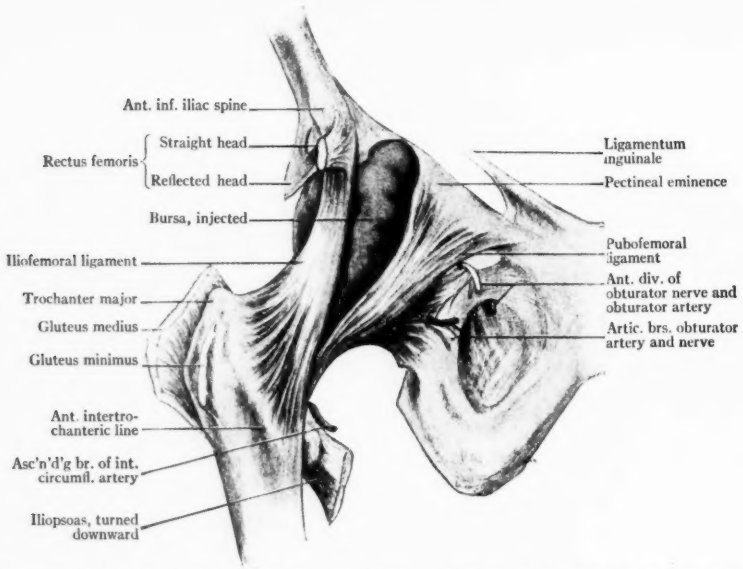


Fig. 2. The iliopectineal bursa injected to show its position and limits (from Heisler's *Practical Anatomy*).

The right hip was held in about 5 degrees of flexion, and attempts to extend it caused exacerbation of pain. The patient held the hip in external rotation. Motion was possible in flexion 45 degrees, in abduction 30 degrees, in adduction 20 degrees, in external rotation 20 degrees and in internal rotation 0 degrees before pain came on. There was no shortening of the leg. The thigh circumference on the right was 1.25 inches less than the left; the calf circumferences were the same. The patient had tenderness on pressure over the front of the hip limited to the point where the iliopectineal bursa is superficial. The front of the right hip seemed definitely fuller than the left. The patient walked with obvious difficulty and with a decided limp.

The roentgenograms were negative except for slight proliferative changes at the margin of the acetabulum.

TYPICAL HISTORY AND EXAMINATION OF ILIOPECTINEAL BURSITIS

The chief complaint is pain in the hip region anteriorly radiating to the front of the knee. The onset is sudden following an injury wherein the psoas muscle is brought into action while the hip is in flexion. At onset the pain is not sufficient to cause alarm or to suggest a serious condition. The patient treats the condition as a "strain" of the hip and continues about his ordinary activities conscious of a soreness in the front of the hip region and at intervals getting a sharp twinge of pain in the front of the thigh which may radiate down to the front of the knee. The pain may be sufficiently annoying to cause the patient to give up work. The patient may notice an increasing tendency to stub the toes of the affected leg, may notice a dragging or heaviness of that leg in walking, all of which probably indicate a weakness of the psoas on the affected side.

If a physician is consulted at that time by the patient, and then radiograms are taken, they will be found negative for hip joint disease, unless the patient be old enough to show proliferative bone changes about the joint margins. Whether the joint shows changes or not, the diagnosis is likely to be "rheumatism." Then will follow the inevitable search for a focus of infection with all the delay, costly diagnostic procedures, and still more costly vain therapeutic procedures including everything which is known in physical therapy, internal medication, and even major surgical operations.

If the medical attendant perchance applies a well fitting plaster-of-paris spica and keeps it on for sufficient length of time to permit the irritation in the bursa to subside, the patient may get well but under almost any other treatment the symptoms are likely to persist until the patient, exhausted in patience or pocketbook, or both, resigns himself to the lot of the crippled arthritic. If, in time, the bursa becomes enlarged sufficiently to produce a tumor in the front of the hip, surgical interference and an inquisitive attitude on the part of the surgeon will doubtless lead to the correct diagnosis.

SYMPTOMATOLOGY

The most common symptom complained of in iliopectineal bursitis is pain in the anterior aspect of the hip joint. The pain may be of an indefinite character described best as an aching pain, or it may be a throbbing pain. If the pain radiates, as it frequently does, it radiates to the front of the knee. This radiating pain is a separate thing from the pain of bursal irritation; it is due to irritation of the anterior crural nerve in its course which overlies the bursa in front of the hip. This radiating pain is of frequent occurrence in iliopectineal bursitis. The pain in front of the hip is aggravated by activity.

Dragging of the leg on the affected side, stumbling, limp, and the weakness of the leg all mean the same thing but represent different expressions of the same phenomenon. Any one of this group of symptoms will be present as soon as atrophy of the psoas muscle takes place, which is very soon after the onset. This weakness in the psoas expressing atrophy of the muscle is increasingly evident if general or local factors, giving rise to muscle fatigue, such as excessive use of the affected extremity, general body fatigue, or toxicity of the body are present. Œdema of the affected extremity is a symptom of infrequent occurrence and occurs only when enlargement of the bursa is sufficiently great and its relationship to the great saphenous vein, such as to cause compression of the venous trunk.

Localized swelling in front of the hip, or tumor formation, occurs only when the bursa has increased greatly in size, commonly in the most advanced stages. The presence of a well defined tumor is indicative of an old and advanced bursitis or an active infectious bursitis.

Flexion deformity of the hip may be present to a very slight degree, even in a relatively early case but marked deformity of this character is commonly associated with marked enlargement of the bursa or an acute infectious bursitis.

Limitation of extension or hyperextension of the hip is but the corollary of flexion deformity and has the same significance.

SIGNS

On inspection of the surface about the hip region nothing abnormal is apparent in the early cases. When, however, the bursa is acutely irritated or when it is distended but not necessarily enlarged, a flexion deformity of the hip will be present. This may be marked enough to be evident on inspection or, if it is very slight, the deformity can be detected only as a limitation of hyperextension.

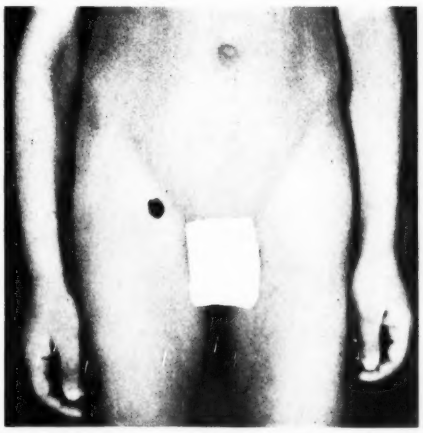


Fig. 3. Black spot marks the area of tenderness elicited in early iliopectineal bursitis.

In the late stages of the iliopectineal bursitis, a tumor mass may be present in the front of the upper end of the affected thigh. In all the cases reported in the literature up to the present time, the tumor was the complaint, the treatment of which led to the diagnosis of bursitis.

Palpation of the anterior aspect of the front of the upper thigh may reveal a slight fulness in that area called Scarpa's triangle. The actual determination of fulness is so much a matter of individual skill in observation and its differentiation from lymph gland enlargement is so difficult that this sign is of small importance prior to the stage in which the tumor becomes well defined.

Probably the most consistent and the most definite finding leading to a diagnosis of iliopectineal bursitis is a point of tenderness, the area of which is not over 2 centimeters in diameter and is always located at a point over the front of the upper thigh or inguinal region. This point is just below Poupart's ligament half way between its attachments to the anterior superior spine and the pubis. It is about 2 centimeters lateral to the femoral pulsation. Without this finding, a diagnosis of iliopectineal bursitis is not justified. This finding alone without confirmatory signs does not justify a diagnosis. However, if definite tenderness on pressure is elicited at the point described, the basis of a diagnosis has been made.

Active hyperextension of the body on the hips and active hyperextension of the affected hip on the body will cause pain in front of the hip, if the iliopectineal bursa is irritated. Active acute flexion of the hip from the sitting position with the knee extended gives a sensation of pain in front of

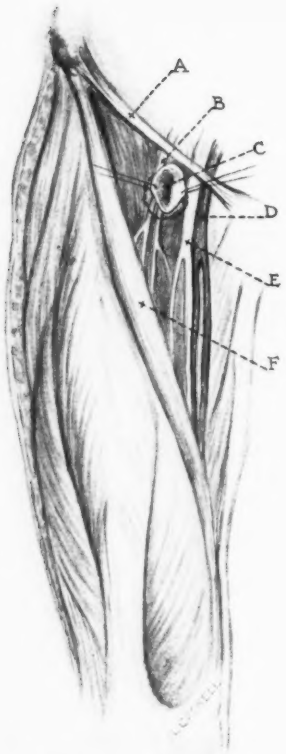


Fig. 4. Bursa in relation to the important nerves and blood vessels on the front of the thigh (after Lund). *A*, Poupart's ligament; *B*, anterior crural nerve; *C*, iliopectineal bursa which has been opened and broken, the center line indicating the extent of the bursa itself; *D*, femoral vein; *E*, femoral artery; *F*, sartorius muscle.

the hip and the maneuver is weak in its performance because of the attendant weakness of the psoas muscle.

Passive hyperextension of the hip on the affected side causes pain in front of the hip region due to the compression of the irritated bursa between the hip joint and the psoas tendon. Where actual flexion deformity of the hip exists any attempt to extend the thigh at the hip will set up a protective muscle spasm and will be very painful. Extreme passive abduction of the thigh at the hip causes pain at the site of the bursa. Internal rotation of the affected thigh also causes pain. Deformity at the hip may vary from a limitation of hyperextension to a marked flexion, adduction and external rotation of the hip, the position of greatest relaxation of the psoas muscle.

Generalized œdema of the affected extremity has been noted but is inconstant in its appearance and is usually present only late in the course of the disease after the more characteristic signs of the condition may be noted. Œdema was noted in only one case in this series.

DIFFERENTIAL DIAGNOSIS

Hip joint disease is easily the most common and the most important condition from which iliopectineal bursitis must be differentiated. If the bursa communicates with the joint, the diseased process, whatever its etiology, would unquestionably involve both the joint and the bursa in which event the existence of the bursitis would be submerged in the more important joint disease. Even so, the bursal lesion might have practical importance as, for instance, in tuberculosis. While it is not necessary to invoke the presence of a communicating bursa with the hip joint to explain the tendency to persistent flexion deformity in tuberculosis of the hip joint, such a situation undoubtedly would increase the tendency to such a condition. The presence of a communicating bursa too would explain the tendency for cold abscesses to present on the anterior aspect of the hip.

An actively diseased hip joint is protected from motion in any direction by muscle spasm. In bursitis, active or passive motion of the joint is possible except in those directions wherein the bursa is pressed upon or distracted. In bursitis, depending upon the stage of the process, flexion deformity ranged from absence of hyperextension to 90 degrees of flexion. Further passive flexion may be possible, however, in bursitis, while in hip joint disease muscle spasm prevents motion in any direction. In bursitis, internal rotation and extreme abduction are provocative of pain. In hip joint disease, the hip tends to assume a position midway between extremes and manifests objection to any motion by muscle spasm.

Tuberculosis of the spine with a psoas abscess must be considered in the differential diagnosis, but tuberculosis of the spine at a stage in which a psoas abscess is present would most certainly be sufficiently advanced to give positive finding roentgenologically and would also give the characteristic clinical findings of such a condition.

Perinephritic abscess or a collection of pus from the retroperitoneal region, finding its way along the course under the psoas muscle would present the condition most easily to be confused with iliopectineal bursitis. The signs of infection in marked proportions would most certainly distinguish the condition from non-infectious bursa

is but might require incision and exploration to distinguish it from an infectious bursitis.

It is quite probable that many slight or early cases of non-infectious iliopectineal bursitis cases have been operated upon with a diagnosis of inguinal or femoral hernia, the diagnosis being a negative one rather than one based on positive findings. Any surgeon engaged in the examination or treatment of hernia should be familiar with the signs and symptoms of iliopectineal bursitis, as well as the mechanism of its production. Such familiarity would most certainly prevent many needless operations for hernia.

PATHOLOGY

While the exact histological structure of the bursæ is still the subject of contention, it may be said that the bursæ are of mesodermal layer origin and are analogous to the joint synovial membrane and the serous membranes. The reaction of the bursal membrane to mechanical or infectious irritation is essentially that of synovial membrane. There is first an increase in the fluid contents of the bursa or an effusion which, in the non-infectious type, subsides if the bursa is put at rest for a sufficient period of time. If treatment is not instituted or imperfectly carried out, the bursa wall gradually becomes thickened to many times its normal thickness. Degenerative changes may occur in the membrane, such as the formation of cartilaginous plaques and large cartilaginous bodies may even develop free in the bursa. In the infectious type of bursitis, the effusion goes on to the formation of pus which requires drainage, or if undrained and not virulent goes on to the formation of a chronic abscess cavity lined with granulation tissue.

TREATMENT

There are certain definite principles of surgical treatment which, if applied to affections of the bursæ, will result in the alleviation, if not the complete cure of those affections. If it be realized that the bursæ are the "bearings" of the body, that they are located wherever motion with the minimum of friction is desired; if it be also realized that the structure of the bursæ is analogous to the lining of the various closed cavities of the body, such as the pleura, the peritoneum and the synovial membrane of the joints, that the first reaction of the bursal membrane is, like in other cavities, an effusion, followed by a thickening of the membrane to many times its normal thickness, if not promptly treated by rest, it will be evident that physiological rest for the affected bursa is the essential principle of treatment. Without rest, other measures are worthless. With rest, heat may be employed to aid in the restoration of the membrane to normal thickness, and the absorption of the fluid. The length of time necessary to restore the bursa to normal varies with the efficiency with which treatment is carried out, but at best consumes many weeks in chronic cases, and is slow even in acute cases. Failure to obtain complete results quickly should not necessitate a resort to focal infection to explain the failure, but should cause the medical attendant to evaluate the skillfulness of his treatment. Even under the most skillful treatment, patience on the part of the physician and the patient is necessary. Repeated aspiration in addition to rest is recommended. If aspiration is attempted, the operator should bear in mind the proximity of the bursa to the femoral artery and the saphenous vein. The pulsation of the femoral artery can be readily obtained and the operator should keep at least 1 centimeter lateral to this point.

Incision and drainage of the bursa in non-infectious bursitis is on a par with the same procedure in a joint in a like condition. It is mentioned here but to condemn it. If any surgical procedure is considered desirable, because of failure of conservative treatment or in order to shorten the period of convalescence, the bursa should be excised as a whole. In infectious bursitis, the surgical principles governing infections obtain. Pus in a bursa must be released by incision and by the maintenance of adequate drainage.

PROGNOSIS

In the early stages of non-infectious bursitis full recovery should occur if the affected bursa is put at rest. Heretofore, the failure to diagnose the condition has made early treatment impossible. Even with early diagnosis the surgical insignificance of the bursa, the unwillingness or inability of the patient to give the necessary attention to rest, or the failure of the medical attendant to understand the necessity of rest will probably terminate in unsatisfactory results.

When the condition has existed for some months, the amount of rest which would be required to clear up the affection is prohibitive. Excision of the bursa may be considered, but its inaccessibility and its proximity to the important femoral artery, saphenous vein, and femoral nerve call for the most careful dissection and inject danger into the case, which should be carefully weighed in each case. Aspiration of the bursa with rest has given good results in some cases and should be tried faithfully before resorting to excision.

In infectious bursitis, the prognosis is directly proportional to the virulence of the infection and to the lack of resistance of the patient. Recovery with good function takes place if surgical measures are not too long delayed.

SUMMARY AND CONCLUSIONS

Iliopectineal bursitis is not uncommon but is not commonly recognized.

Failure of recognition results in mistaken diagnosis followed by serious surgical measures and at times by serious disability.

The symptoms and signs of the condition are clear and permit a clear cut differential diagnosis.

The treatment of the condition is the treatment of any bursitis and the results of treatment are commensurate with the appreciation of the underlying etiological factors and the surgeon's understanding of the pathology of the bursa.

The location of tenderness in iliopectineal bursitis is so definite that its elicitation may be said to constitute the basis of a diagnosis.

The frequency of communication between the bursa and the hip joint obligates the orthopedist to consider this bursa in all considerations of hip-joint complaints.

BIBLIOGRAPHY

1. Auray. Bull. et Mém. Soc. de Chir. de Par., 1919, 980.
2. Baker. St. Barth. Hosp. Rep., 1885, xxi.
3. Charleston. J. Am. Med. in Centralblatt, 1880, p. 127.
4. Chassaignac. Traite de la suppuration et du drainage, 1859. Vol. ii.
5. Chastenet de Gery. Bull. et Mém. Soc. nat. de Chir., 1928, liv, 1466–1472.
6. Codman. Boston M. & S. J., 1908, Oct. 22, 29, Nov. 5, 12, 19.
7. Cullen. J. Am. M. Ass., 1910, April 9, 1181.
8. Dagron. Bull. Soc. Anat. de Par., 1891, 96.
9. Delbet. Bull. et Mém. Soc. de Chir. de Par., 1902, xxviii, 1264.
10. de Weck and Duprez. Rev. méd. de la Suisse Rom. 1900, xx.
11. Durville. L'hygroma de la bourse sercuse du psoas 1895.
12. Ehrlich. Fortschr. a. d. Geb. d Roentgenstrahlen 1928, xxxvii, 847–851.
13. Fricke. J. d. Chir. u. Augenheilk., 1834, xxi, 235.
14. Gatch and Green. Ann. Surg., 1925, lxxxii, 277.
15. Hammesfahr. Zentralbl. f. Chir., 1929, lvi, 285–28
16. Heineke. Memoire paru a Erlangen, 1868, 104.
17. Hoffa. Monatschrift f. Unfallheilk., 1889, c, 287.
18. Joessel. Topographisch-Chirurgische Anatomic, 16
19. Joly. Ghese Inaugurale, Paris, 1847.
20. Kessel. Morphol. Jahrb. 58: 413–430, December 192
21. Kummer. Rev. méd. de la Suisse Rom., 1917, xxxvi, 574.
22. Lund. Boston M. & S. J., 1902, Sept. 25, 345.
23. Maissoneuve. Clinical Chirurgicale, Trad. franc xiv.
24. Mommsen. Deutsche med. Wchnschr., 1895, x 107–109.
25. Mondain. Arch. méd. d'Angers, 1889, iii.
26. Osgood. Bursae. Vol i, 2. Oxford Surgery.
27. Pisano. Policlin., Roma, 1913, xx, 415–445.
28. Prengrueber. Gaz. Hôp., 1885.
29. Rose. Lancet, 1873.
30. Schaeffer. Centralbl. f. Chir., 1880.
31. Sonneborn. Inaugural Dissertation, Marbourg, 189
32. Sorrel. Bull. et Mém. Soc. Nat. de Chir., 1929, lv, 98–100.
33. Sprengel. Centralbl. f. Chir., 1887.
34. Volkmann. Krankheiten der Gelenkorganen. Vol. ii.
35. Zuelzer. Deutsche Ztschr. f. Chir., 1889, l, 148.

FRACTURE OF THE NECK OF THE FEMUR

A Sight for Accurately Directing the Dowel Peg

STERLING BUNNELL, M.D., San Francisco, California

SURGEONS the world over complain of inability to direct the bone-peg accurately in repairing a fractured femoral neck. Some are naturally so gifted that they can usually drill the hole for the peg or can hammer the nail blindly straight through the narrow (2.8 centimeters) neck of the femur and into the center of the head, but there are instances aplenty when the peg or nail missed the central course and was demonstrated by X-ray to be even outside the neck or head, resulting in intense anguish to all concerned.

Shapes of femurs like faces are remarkably variant as is apparent when reviewing a large series. Also, the aim of the surgeon, guided by measurements and angles through this intricate target shielded as it is from vision, is subject to much error. There are always more shots around the target than in the bull's-eye. If, however, the two sights of a gun are properly alined the bull's-eye is hit.

THE PRINCIPLE

The following method is offered in which the peg is directed automatically and accurately exactly where desired. The instrument has a front and rear notch or sight 3 inches apart into which the drill is laid and so directed. The rear sight is on a slider and as the drill penetrates the bone the rear sight follows along, always keeping the drill accurately in its course.

The sights are automatically aimed by contacting the apparatus by direct vision with the shaft and neck of the femur through the two usual lateral and anterior incisions.

The apparatus has two arms, each terminated by a tiny metal spike. That on the shaft arm is thrust into the femoral shaft just below the greater trochanter and that on the neck arm is driven up to its shoulder into the center of the femoral neck just proximal to the fracture (Fig. 3). This aims the apparatus and now a drill guided by the sight is certain to penetrate through the exact center of the femoral neck.

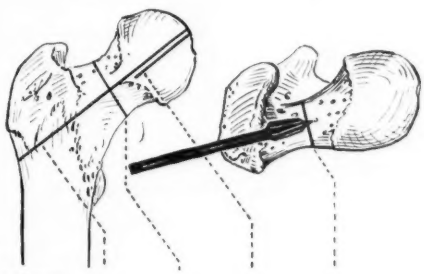
The center of the drill guided by the two sights is bound to pass directly in line with the neck arm of the apparatus and just 14 millimeters from the shoulder of the spike. As this shoulder is in contact with the center of the anterior surface of the neck the drill will pass through the center of the neck which has an average thickness of 28 millimeters (Fig. 6).

MEASUREMENTS OF FEMURS

To ascertain the average size and the variation from it, the following measurements were taken from fifty femurs: (1) vertical depth of neck at its middle and at a right angle to the neck; (2) width of neck anteroposteriorly at its middle and at a right angle to it; (3) maximum distance in direction of peg; (4) length of head measured from its anterior lip; (5) length of femur from the bottom of the internal condyle to the top of the greater trochanter.

	Depth of neck—cm.	Width of neck—cm.	Length in direction of peg—cm.	Length of head—cm.	Length of femur—cm.
Average	3.6	2.8	10	3.5	47
Maximum	4.7	3.3	11.1	4.0	49
Minimum	3.0	2.5	8	2.8	39
Variant	1.7	.8	3.0	2.2	11.1

The neck widens slightly toward the head and the head is in the direct line of the neck. The greatest width of the neck near the head is between the upper and middle thirds and near the trochanter between the lower and middle thirds. The neck tapers anteroposteriorly and widens vertically as it approaches the trochanter and



Maximum	11.1	4.7	4.0	3.3
Minimum	8.0	3.0	2.8	2.5
Average	10.0	3.6	3.5	2.8
Variant	3.0	1.7	2.2	0.8

Fig. 1. Measurements (in centimeters) determined from 50 femora.

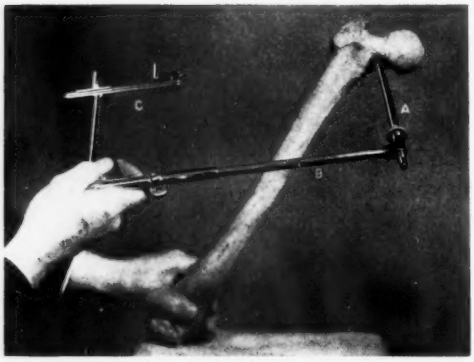


Fig. 2. To apply the sight to the femur the spike of the neck arm, *A*, through the anterior incision is driven into the femoral neck. Then by adjusting the length of the sliding arm, *B*, the shaft arm, *C*, of the sight can be made to enter the lateral incision and contact with the femoral shaft.

joins the trochanter in an oblique plane from forward and above running backward and downward.

DIRECTIONS FOR USE

The sight as pictured in Figures 2 to 7 is strongly made of tool steel and is an instrument of precision. It is applicable for use with the Albee motor driven bone mill or any other standard make. The Albee technique of the operation is followed, the merits and success of which I can personally vouch for as Dr. Albee performed his operation on my own hip.

Through the vertical incision just internal to the anterior superior spine of the pelvis and between the rectus and iliacus muscles the fractured femoral neck is exposed. The bone ends are freshened and accurately fitted together, the

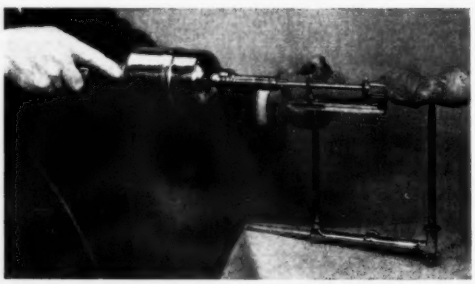


Fig. 4. Aiming of sight as seen from above. Both arms of sight are pegged to the femur, so the drill will enter the center of the flat surface 13 millimeters below the ridge of origin of vastus externus and will pass through the femoral neck just half the width of the neck away from the terminal shoulder of the neck arm.

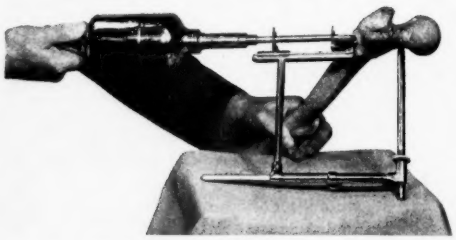


Fig. 3. The sight is aimed by driving the two sma terminal spikes into the neck and shaft of the femur. Th drill now laid in the two notches or sights will be accurate directed.

patient's legs being held securely with traction o the orthopedic table.

Through a vertical lateral incision the shaft the femur is exposed below the upper attachmen of the vastus externus. The bone peg shoul enter the center of the flat area 13 millimeter below the ridge of origin of the vastus externu (Fig. 4) and should run exactly through the thick est part of the neck and into the head so that i terminates where the head is longest and abov the ligamentum teres. It should avoid th vicinity of the ligamentum teres so that this im portant blood supply to the head will not b damaged (Fig. 7). In order to guide the peg exactly right the spike of the neck arm of the sight should be driven into the femoral neck slightly above the center of the anterior surface of the neck. This slightly upward direction o the peg is better also for strength as it is more in line with weight bearing.

The length of the neck arm of the apparatus is so adjusted by the set nut beforehand that the point of the drill, when the drill is guided by the two notches or sights, will pass the end of the neck arm just 14 millimeters from the shoulder of its terminal spike (Figs. 5 and 6). Femoral necks range in thickness from 2.5 to 3.3 centimeters, thus having a variant of 8 millimeters of thickness or a 4 millimeter variant to the center of the neck. The length of the neck arm is readily adjustable for this, if for the sake of accuracy it is desired. The fixed measurement of 14 millimeters, however, will be satisfactory for any width of head.

The ¼ inch spike on the end of the neck arm o the apparatus is hammered to its shoulder int the neck of the femur slightly above the center o its anterior surface and just proximal to the fracture line (Figs. 3, 4, and 6). At this stage the bone ends should be held together. By loosening the set screw the sleeve of the apparatus can b drawn out so that the shaft arm can be made t

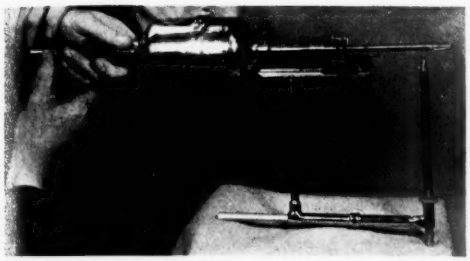


Fig. 5. As the drill penetrates the bone the sliding rear sight follows along always keeping the drill accurately in its course. As soon as the drill point is engaged in the bone the rear sight alone does the guiding. The length of the neck arm of the apparatus is so adjusted by the set-nut beforehand for the average size of femur that the point of the drill, when the drill is guided by the two notches or sights, will pass the end of the neck arm just 14 millimeters from the shoulder of its terminal spike.

enter the lateral incision (Fig. 2). The spike on the shaft arm is hammered into the shaft of the femur so that the drill when laid in the two notches 3 inches apart will touch the femur with its point at the center of the bare flat area and 13 millimeters below the ridge of origin of the vastus externus (Figs. 3 and 4). The set screw is tightened and the sight is held in place firmly by an assistant.

The fracture line is then allowed to gap a little so that the assistant can announce when the drill, which is now driven through the bone, reaches that far. The fractured ends are then again put in place and the drill is continued on into the femoral head to the depth desired as read on the scale on the shaft of the drill. Usually the length of the head is equal to the vertical depth of the femoral neck at its center, though there is a maximum variant in this measurement of 14 millimeters. The exact proportion between the length of the distal and proximal bone fragments can be seen in the X-ray films and so the penetration by the drill beyond the fracture can be calculated. Due to absorption in the neck the length of the peg required is usually 7 or 8 centimeters instead of 10 centimeters or average maximum distance measured in intact femurs.

The machine made autogenous dowel peg is passed into the drill hole by gentle taps of the hammer and the bone fragments are jammed together by pounding on a mallet with its handle against the femur.

AN ADDITIONAL TECHNIQUE

Here a refinement of technique may be added because, by using the sight, the position of the peg in the femoral neck is accurately known. There is a tendency for the femur to fall away from its head, especially if the peg is at all loose. A cardinal principle in bone grafting is to fit the parts accurately together and to hold them firmly and without the least motion. With the Albee

Fig. 6. A quadrant has been cut from the femoral neck to expose the drill passing accurately through the center of the neck. It cannot fail in its aim as the center of the drill must pass the end of the neck arm at an exact distance from the shoulder of the latter, which is contacted with the anterior surface of the femoral neck.

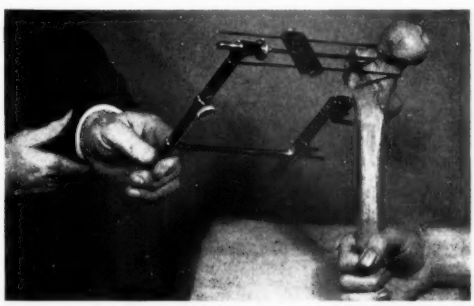


Fig. 7. Use of sight without exposing the femoral neck. Method of accurately placing the neck arm of the sight on the femoral neck without making the anterior incision. The lateral incision alone is used to expose the shaft. The neck arm has by removing its shoulder bearing sheath been converted to the thickness of a Steinmann pin. By sense of touch two pointed knitting needles thrust through the skin are made to mark the upper and lower borders of the femoral neck. They are then by set-screws clamped firmly in a block, through which is a channel to guide accurately the Steinmann pin or neck arm, to prick into the anterior surface of the femoral neck at the point desired.

mill it is easy to fashion two round autogenous bone pegs, each the size of a match, and pass them through drill holes at a right angle to the neck to pin the peg in place in both the distal and proximal fragments. If the drill holes are threaded by a thread tap the unthreaded pegs hammered into these holes will hold firmly.

USE OF SIGHT WITHOUT EXPOSING THE FEMORAL NECK

There will always be a percentage of failures to obtain union by the Whitman or any other closed method of setting intracapsular fractures of the femoral neck, because so often torn capsule and soft parts are found between the fragments. This applies even if a peg or nail is used unless the fracture line is openly inspected and the soft parts are removed from between the bone ends. Therefore, at least in operations for non-union, the anterior incision exposing the femoral neck is advised. For those desiring to insert a nail, beef bone, or other dowel through the femoral neck and to use only the lateral incision as in a primary operation, the use of the sight is still available as the neck arm is at once made slender and shoulderless at the point by sliding off from it a tubular sheath which was there for strength and to provide the terminal shoulder (Fig. 7). This narrow neck arm like a Steinmann pin may be thrust through the anterior surface of the thigh to prick into the center of the femoral neck. The center of the neck may be determined by guidance under the fluoroscope when verifying the set of the fracture or more simply by the following method.

After the fracture is set and the position verified by X-ray a 9 inch slender pointed rod or a knitting needle is thrust to the femoral neck and by feeling the way is passed just over the upper border of the neck and left there as a guide. Similarly another needle is thrust through the skin 1½ inches below it and by sense of touch is thrust just past the lower border of the neck. A metal block with two small holes 1½ inches apart is then passed over the two projecting ends of the needles and is by two set screws clamped solidly with the needles in the holes (Fig. 7). Through the center of the clamp is a channel which is made so that it points to just above the center of the neck of the femur. This is easily possible because one guide needle marks the upper and the other the lower border of the femoral neck. Through this channel or hole as a guide the slender neck arm of the sight is passed and thrust through the skin to the center of the femoral neck and with a light tap is fixed there. Thus when advisable the sight will accurately guide the drill or nail without the necessity of exposing the neck of the femur.

A few trials on the cadaver will readily verify the accuracy and ease of this method.

If a nail flanged or otherwise is used it can be directed by the sight. A special nail set is attached firmly to the head of the nail to receive the blows of the hammer and is laid in the notches of the sight just as is the drill when preparing a hole for the dowel peg. For this use the spike screwed on the end of the shaft arm is changed for a longer one so that the front sight will clear the nail.

VARICOGRAPHY[1]

MAURICE M. POMERANZ, M.D., AND ISIDOR S. TUNICK, M.D., NEW YORK
Hospital for Joint Diseases

THE use of contrast media to visualize roentgenographically inaccessible cavities or hollow organs is now a commonplace procedure. The value of these drugs originally depended on their radiopacity, but as research in this field developed, agents were produced which possessed in addition therapeutic qualities. These media were first introduced by injection or instillation, in order to visualize local parts, but the science developed rapidly, so that today, many chemicals are introduced intravenously in order to render distant organs opaque. In many instances these drugs, in addition, permit studies of the secretory or excretory capacities of the tracts so visualized. Few organs today remain inaccessible to roentgenographic demonstration.

The injection of opaque material to visualize vascular channels has heretofore been restricted to specimens removed at autopsy, operation, or in animal experimentation. Its employment *in vivo*, however, is of more recent origin and has been made possible by the development of opaque solutions which can be introduced directly into the circulation without deleterious effect. In this study, the venous channels of the lower extremity were injected with skiodan. Our objects were (1) to visualize the morphological changes that occur in varicose veins, (2) to determine the character of the associated circulatory phenomena, and (3) to discover if possible the presence or absence of vascular pools or venous channels subjacent to varicose ulcers.

ANATOMY OF NORMAL AND PATHOLOGICAL VEINS

A brief review of the normal and morbid anatomy of the veins of the lower extremity will facilitate greatly an understanding of our objectives. The venous channels of the lower extremity consist of two sections, the superficial and deep. The former is composed of two trunks, the long and short saphenous veins. The long saphenous vein is placed at the antero-internal aspect of the leg and is formed by the confluence of the veins on the internal aspect of the foot and ankle. Beginning slightly above the internal malleolus, it is directed upward internal to the tibia and posterior and internal to the internal condyle of the femur. As it continues upward it inclines forward and outward to reach Scarpa's triangle, where it terminates in the femoral vein. The short saphenous vein is formed over the posterior and external aspect of the foot. It passes at first below the external malleolus and then ascends behind the external malleolus along the outer border of the Achilles tendon to the middle of the calf above which it is continued in the superficial fascia to the popliteal space to terminate in the popliteal vein. The deep veins of the lower extremity are situated in and collect blood from the deep tissues of the foot and ankle and in the popliteal space they form the popliteal vein which is continued upward into Hunter's canal to become the femoral vein. These venous systems form an extensive anastomosis over the leg and thigh. Communication between veins is by the venæ comites whose number and relation vary greatly (1, 4).

Normal veins pursue a straight course without kinks or tortuosities. The veins differ from arteries in that they are provided with valves whose free borders are directed toward the heart. In the smaller veins these valves are single but in the larger veins they may be double or even triple. The integrity of this valvular mechanism in great measure determines the competency of the venous system, as will be seen later.

Varicose or dilated veins assume various bizarre shapes. Masses of these clumped veins protrude under the skin as nodular or saccular unsightly masses. The walls of the afflicted vein become extremely thin and at times even calcified, so that they may be demonstrated on flat plates of the extremity. As a result of vascular stasis, phlebitis and thrombosis are common. Deficient aeration and œdema of the soft parts favor the formation of ulcers on the slightest trauma and these ulcers are prone to become extremely indolent and difficult to cure. Involvement of the subcutaneous veins frequently results in thickening of the skin with the formation of eczematous patches.

Under normal conditions, blood takes the shortest route to the heart and the direction of the flow in the veins of the lower extremity is in the main upward. Circulation from the superficial to the deep vessels, via the communicating veins is possible; reversal of the flow occurs in disease. Normal circulation is the product of the pump-like action of the muscles associated with the aspiratory effect of the pelvic vessels and the changing intra-abdominal pressure produced in respiration. In order to maintain normal direction and

[1] From the Department of Roentgenology, and the Varicose Vein Clinic. Presented at the Orthopedic Section, New York Academy of Medicine, February 17, 1933.

pressure, the efficiency of this tubular system must be maintained.

In disease, however, some portion of the system becomes damaged and as a result definite changes occur in the direction of the flow. Since the deeper system is protected by surrounding muscles and a more liberal valvular mechanism, it consequently remains relatively normal; but the superficial system being unsupported and possessing fewer valves, undergoes distinct changes and the normal hydrostatic pressure in the system is destroyed. The severity of this disturbance will in a great measure depend upon the degree of incompetency of the valves which nature has erected as dams along these channels. Under these circumstances, the circulation becomes slowed up and even reversed. This effect can readily be demonstrated on intravenous injection of opaque solutions during fluoroscopy. Clinically, however, the Trendelenburg test permits us to observe this phenomenon and a brief description of it will be of interest to our readers.

In the recumbent position, after the veins of the lower extremity have been emptied by elevation, a tourniquet is applied at the mid-thigh and the patient permitted to stand. Where varicose veins exist, it will be noted that there is distention of the veins above the tourniquet; whereas the veins below remain collapsed. If the tourniquet is removed the veins below fill rapidly. This is called the Trendelenburg positive and is due to incompetence of the valves of the superficial saphenous system.

The rapid downward descent of the column of blood in the veins from the saphenofemoral opening often imparts a distinct thrill to the palpating fingers. When the tourniquet is tightly applied with the patient in the upright position, if the veins fill rapidly from below, we have the Trendelenburg negative. This is due to valvular deficiency in the communicating system. If, on application of the tourniquet, the veins fill rapidly from below and are still further distended on removal of the tourniquet, we then have the Trendelenburg double. This phenomenon is due to incompetency of the communicating veins as well as back flow through the great saphenous vein. To prove these observations, McPheeters (3) injected lipiodol into two living subjects and observed the venous flow during fluoroscopy. The objection to lipiodol is that its specific gravity is greater than blood and it may of itself gravitate to peripheral parts and thus simulate reverse flow. However, he (4) subsequently repeated his experiments utilizing skiodan; the medium which we have employed for contrast purposes.

TECHNIQUE

Any syringe and needle used in the injection treatment of varicose veins may be employed and from 5 to 20 cubic centimeters of a 40 per cent skiodan solution is sufficient for the study. Patient prepared as for intravenous medication. The use of the tourniquet is optional as venous dilatation is so great that satisfactory plates may be taken without its use. To test the mechanics of the Trendelenburg test, the tourniquet must be employed. The patient is placed upon or in front of the fluoroscope and the needle inserted into the vein. When we are assured that the needle is within the vessel, the material is injected slowly and without undue pressure during fluoroscopy and the veins studied under varying conditions of pressure and posture.

For record purposes, stereoscopic plates are taken. The limb is placed upon a plate changing device and the vein injected while the plates are being taken. The needle should not be removed between exposures since it serves as a guide to the site of injection and prevents back flow of the skiodan upon the skin, where its superimposed density often masks finer vascular changes. In severe cases, satisfactory plates may be taken with the patient in the horizontal position; but to detect early changes, the vertical position is preferable. If an ulcer exists, any small metallic device may be employed to mark its site, or a fine wire may be molded about its periphery to define its extent more clearly. At times it may be desirable to take plates in both the horizontal and upright positions. Because of venous stasis and the slow dilution of the dye, this may be accomplished frequently without reinjecting the vein. If necessary, however, the procedure may be repeated for further study.

Veins in which a latent phlebitis exists, are usually tender on pressure and warmer than the surrounding tissues. In such instances, the quantity of injected material must be reduced or else the latent process may become active and extremely distressing.

ROENTGENOSCOPY AND ROENTGENOGRAPHY OF NORMAL VEINS

By the use of stereoscopic plates, the venous system may be studied to an astonishing degree and the extremely rich circulatory channels of the thigh and leg traced from their origin to their termination. One obtains at a glance a panorama of the extraordinary anastomosing plexus. Normal veins pursue a straight course, without kinks or tortuosities, but gentle curves and undulations are common. In the main, the caliber is fairly even

throughout, and the terminal filaments taper off gradually to inconspicuous tubes. Sudden constrictions may normally exist and probably represent local spasms due to irritation by the chemical or needle. These pass off quickly and the normal caliber of the vessel is re-established. A careful examination of the roentgenograms often reveals oblique channels within the walls produced by intramural vessels. Sudden variations in the density of a vein as seen on the flat plate may be accurately identified by stereoscopic films. They do not represent the valvular mechanism but the exit of small communicating veins the axes of which are perpendicular to that of the parent vessel or else they represent the superimposed shadows of vascular loops.

The valvular apparatus may be studied best in normal veins and those of the arm are particularly suited for this purpose. Plates may be taken with the extremity in either the horizontal or vertical position. The appearance of the segments at the site of the valves will vary, depending on the phase of valvular excursion during which the plates are taken and on the relation of the angle of the tube to the plane of the valves. Stated otherwise, the appearance of the valves on the roentgenogram will depend upon whether the central ray passes parallel or perpendicular to the plane of closure of the valves. The best demonstration occurs when the plane of the valves and the central ray coincide.

The valves are usually situated distal to the point of entrance of the communicating vein. We have found that muscular individuals have a more liberal valvular mechanism; men possess more valves than women; and stout females more than those of the asthenic habitus.

The first impression of the valve area is that a portion of a vein has been invaginated into the segment above it. On close inspection of this area, however, it will be noted that the picture is composed of several details. If the valve is partially open, two extremely fine lines may be noted converging toward the center of the vein. These are the leaflets. External to these leaflets, symmetrical bulges are present in the vein wall representing the filled paravalvular sinuses. Within these sinuses, distinct concentration of the dye occurs and is due to the slightly retarded circulation at the periphery of the veins. In the center of the vein, there is slight dilution of the dye, due to the relatively swifter current. If the valve is closed just as the plate is taken, the symmetrical bulge in the vessel wall is still present but there is in addition an extremely fine transverse density produced by the dye as a result of a momentary

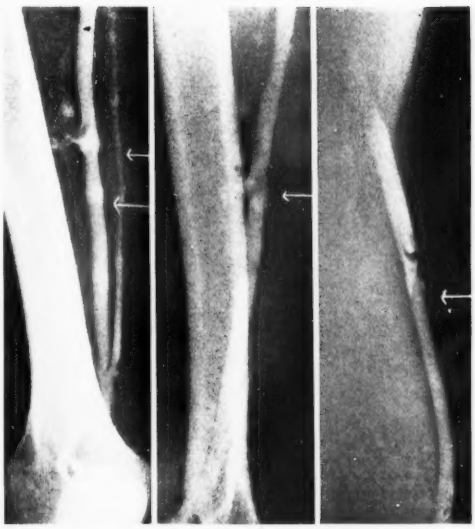


Fig. 1. The valvular mechanism in the normal veins of the arm. Valve leaflets represented by two light lines which converge toward the lumen of the vein. Note symmetrical concentration of the dye in the lateral sinuses. Transverse densities represent valve areas, where the projection of exposure is perpendicular to the plane of closure of the valves. Note entrance of communicating veins proximal to valves.

delay in the venous flow. Occasionally, the symmetrical bulge may be present and within it transverse or oblique densities are demonstrated. This picture is produced technically by the projection of the exposure in a direction perpendicular to the plane of the valves so that we are, so to speak, looking down the veins toward the valves (Fig. 1, a, b, c).

Veinoscopy permits us to visualize the movement of the dye under various conditions. It will be observed as the mixture is introduced that it is rapidly taken up by the blood stream and swirled upward in the direction of the heart. Most of the chemical is carried by the main stream but some of it escapes into the lateral radicals and a smaller quantity into the deeper vessels. A slight but distinctly limited back flow occurs due probably to the force employed by the syringe method of introduction. However, extensive reflux does not occur in normal veins as the downward migration of the fluid is quickly checked by the nearest valve.

If the vessel is injected while the patient is in the vertical position, the mechanism of the flow as outlined above still obtains but the circulation appears to be retarded somewhat. The reflux of

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 2. Bulbous enlargement in the popliteal region. Note the concentration of the dye in the distended lumen. The second exposure was made immediately after and shows retrograde extension of the dye, although stasis persists in the loop.

Fig. 3. Venous pools and stasis with moderate concentration of the dye at the base of a varicose ulcer.

Fig. 4. Illustrating the extreme tortuosity of varicose veins. The veins were injected in the thigh and marked retrograde circulation is demonstrated.

the fluid from the site of injection does not appear to be greater than that which is noted when the patient is in the horizontal position; the returning stream is checked by functioning valves. Without instruments of precision, we were unable to study the difference in the rate of flow in these two positions.

The application of pressure to the area of injection rapidly spreads the dye in all directions but mainly in the direction of the normal flow. Muscular movements are but another form of pressure and assist materially in emptying the vessels. The dilution of the dye is so quick and its passage so rapid that no effort was made to study the effect of respiration on normal venous circulation. This could be studied much more satisfactorily in pathological veins.

ROENTGENOSCOPY AND ROENTGENOGRAPHY OF ABNORMAL VEINS

Despite our knowledge of the subject and our appreciation of the pathology of varicose veins, the extent of the process as revealed by skiodan is truly astonishing. In our series, the dye revealed involvement of the vessels to a degree unsuspected by the physical examination.

Not only is there a dilatation of the affected vein, but there is in addition an apparent increase in its length. The vessels acquire bizarre shapes, the commonest of which is the formation of loops or coils which extend in all directions. The appearance of these loops will vary, depending on the plane along which the dilated vein extends. On the anteroposterior plates circular dilatations may extend to the right or left of the axis of the vessel. On the lateral plates, one often sees bunches of dilated loops apparently suspended from the vessel in "grape-like" formation. Commonly these loops press upon each other, producing a localized obstruction and the circulation in these areas is consequently delayed. Stasis results with concentration of the dye in the most dependent portion of the loop (Fig. 2). On the other hand, if the direction of the exposure is perpendicular to the plane of these vessels, nodular or "pearl-necklace-like" dilatations are seen. These appear to be more common in the most superficial vessels. "Whorl" or "sky-rocket" dilatations are common and these superficial varicosities often indicate fairly extensive disease in the more deeply situated vessels of the superficial venous system.

We are inclined to believe with Sgalitzer that the motheaten indentations which are noted in some of the vessels represent a localized inflammatory process in the wall or else thrombosis of the vessel.

Venous pools are common in the vicinity of ulcers and feeder veins which enter the base of ulcers may be easily demonstrated by a simple procedure. The site of the ulcer is marked and the vein injected with the patient in the horizontal position. Having completed the study of the vessels, the limb is elevated and the veins quickly

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 5. Comparison of normal with pathological vein. Note dilatation of communicating venous system. Stereoscopic vision shows a vein completely encircled by a communicating vein (below circular density in mid-calf).

Fig. 6. The veins were injected in the popliteal region. Note retrograde circulation and concentration of the dye in the loop. "Pearl-necklace" type of varicose veins.

Fig. 7. An advanced case. Note dilatation of venous loops. Plates taken in horizontal position. There is no dilution of the dye despite the large volume of blood in the vein.

emptied. Even in the most extensive dilatation some residue of the dye will be observed at the base of the ulcer, although the remainder of the vain has been completely emptied (Fig. 3).

Multiple kinks may be seen in localized segments of the vessel and result in deflection of the circulation. Sudden dilatation of the vessel wall proximal to the kink may indicate moderate obstruction at this level which appears to be further corroborated by the concentration of the dye and venous stasis (Fig. 4).

As a result of the marked phlebectasia, secondary dilatation occurs in the veins of the communicating system. The accompanying vein, however, even in extensive disease, may be perfectly normal. At times a normal vein may be completely encircled by the loops of distended vein (Fig. 5).

Often the varicosities will involve a limited area of the vessel, the segments above and below it remaining perfectly normal. On the other hand, what appears on physical examination to be a limited varicosity will be found to be an extreme case wherein only the most superficial loops are visible to the naked eye. In a few of our cases, localized bulbous enlargements of the calves were found to be due to extreme dilatation of the vessels which were somewhat masked by the adipose tissues. The futility of attempting to accomplish a cure by conservative treatment or by limited injections is obvious (Figs. 6 and 7).

The typical valvular mechanism of the venous system is not demonstrated to any great extent in varicose veins. Residual valvular structure may be represented as unilateral linear filling defects in the contrast media or at the site of localized bulbous swellings in the course of the vessel.

We have examined our patients in the upright, vertical, and Trendelenburg positions. Satisfactory studies may be made in the horizontal position, since venous stasis even in this position is so marked, that the dye remains practically motionless for a considerable period after injection. In moderately severe cases, without the use of a tourniquet and with the patient in this position, retrograde circulation occurs and concentration of the dye results. The incompetency of the valves of the superficial system (Trendelenburg positive) is thus simply established. This observation is of practical importance in considering the efficacy of sclerosing mixtures. We injected skiodan above or proximal to the ulcers, and retrograde obliteration of the vessel occurred with healing of the ulcer. In most instances it would seem preferable to inject the veins somewhat proximal to the segment to be obliterated.

The centrifugal flow of disordered venous circulation may be studied most characteristically with the patient in the upright position. All of the morphological and physiological alterations referred to are present to an exaggerated

Fig. 8. Venous angioma of the neck injected with skiodan.

degree. These changes have already been described and it becomes necessary only to refer to another phenomena. The formation of loops is a characteristic of the disease. They are usually so placed that their ends are upward toward the heart. The development of stagnant venous lakes is thus favored, within which distinct fluid levels may be demonstrated. In this situation stasis is extreme and concentration of the dye pronounced.

At times moderate dilatation of a vein occurs but no retrograde circulation results. This is due to the fact that the valvular mechanism is still intact (Trendelenburg nil). Under fluoroscopic observation after injection, it will be noted that the dye is transported centripetally at a somewhat retarded speed. Veinoscopy in this instance will show slight dilatation of the vessel but no marked distortion in its contour. To test the mechanics of the Trendelenburg negative (incompetency of the valves of the communicating system) would have necessitated exposure of the deep veins and injection with skiodan. This procedure was not considered justifiable in any of our cases.

Pressure applied by the palpating finger or represented by the force of contracting muscles rapidly spreads the skiodan throughout the venous channels in a manner that demonstrates the break down of the regulating mechanism. The communicating and deep veins may be quickly filled and the venous trunk visualized for a distance of 4 to 6 inches. Most of the dye will be projected peripherally to remain for a considerable period in remote venous loops. Some of it may be forced upward to pursue a tortuous and devious route to the heart. Where extensive disease exists, it is surprising to observe the

Fig. 9. Plate taken in upright position and showing horizontal fluid levels.

degree of force necessary to empty the venous channels completely.

It is agreed and accepted that respiratory movements assist circulation. If varicose veins exist, we have found that respiratory movements are wholly ineffectual in emptying the superficial vessels. Whatever aid to the circulation these movements have, is apparent only after the blood enters the deeper veins. Of the respiratory phases, forced expiration appears to be a decided factor in assisting the flow in the deeper vessels. Deep inspiration, since it is accompanied by increased intra-abdominal pressure, is of no material aid to the circulation.

VENOUS ANGIOMATA

During the course of this investigation, a patient with an extremely large venous angioma of the neck presented herself in the outpatient department. The veins were so distended that they formed a large unsightly tumor. She refused operation and skiodan was therefore injected and the mass studied by means of stereoscopic plates. The angioma consisted of innumerable convoluted and dilated vessels so closely intertwined that identification of individual loops was difficult, and their point of origin from the local venous system impossible to determine. Sgalitzer and his workers described the appearance of

hæmangioma after injection of skiodan and subsequent obliteration by a hypertonic sugar solution. Our own case showed practically complete obliteration of the angioma 3 days after the injection of skiodan, without the use of any other agent. In this instance, the skiodan served a double purpose. It permitted us to visualize the angioma and at the same time acted as a sclerosing agent the effect of which was as satisfactory as that obtained by any of the other chemicals employed for this purpose and produced less reaction than sodium chloride, sodium salicylate, or their derivatives (Fig. 8).

SEQUELÆ

In none of the patients was there any untoward effect. It is axiomatic, of course, that intelligent employment of any intravenous medication demands its introduction into the vein and not into the tissues about it. Fortunately there are no difficulties in entering varicose veins and in none of our cases did any of the chemical get into the perivascular tissues. No sloughs were therefore produced.

By this method, an occlusion of many vessels was rapidly accomplished particularly in those cases with a Trendelenburg positive. The venous angioma referred to was sclerosed in 3 days. In another patient 4 inches of the vein was collapsed 24 hours after treatment. In the 48 cases that were studied, the obliteration of the vessel appeared to be somewhat faster with skiodan than with other salts.

One of our cases was extremely instructive. This patient had an ulcer about 1½ inches in diameter over the internal malleolus, which had persisted for 9 years. Her veins were injected in the calf and the ulcer healed completely in 19 days. The retrograde circulation and sclerosing effect of the chemical was thus beautifully illustrated.

CONCLUSIONS

The injection of skiodan into varicose veins offers a safe method of visualizing the venous system. By the use of this chemical during fluoroscopy we are able to observe the circulation of the blood in diseased veins and its variations during changing mechanical conditions. The static implications of the Trendelenburg test, observed by this method by McPheeters, have been confirmed by us. By the use of stereoscopic plates we can record the physical conditions of the veins at the time of injection. The use of this chemical results in sclerosis of the affected vein which is painless and unaccompanied by periphlebitis. We have demonstrated to our satisfaction, the presence of venous pools and feeder veins in the vicinity of varicose ulcers.

REFERENCES

1. Cunningham. Text Book of Anatomy. New York: William Wood & Co., 1903.
2. McPheeters. Varicose Veins. Philadelphia: F. A. Davis Co., 1929.
3. McPheeters, Merkert, and Lundblad. The mechanics of the reverse flow of blood in varicose veins as proved by blood pressure readings. Surg., Gynec. & Obst., 1932, lv, 298–302.
4. Morris. Human Anatomy. 4th ed. Philadelphia: Blackstone, 1907.
5. Sgalitzer, Kollert, and Demel. Kontrastdarstellung der Venen im Roentgenbilde. Klin. Wchnschr., 1931, No. 36, 1659–1663.

THE EVALUATION OF SODIUM MORRHUATE THERAPY IN VARICOSE VEINS

A Critical Study[1]

HYMAN BIEGELEISEN, M.D., New York

THE introduction of any new agent in therapeutics is invariably hailed with enthusiasm. Following this, comes a period of reaction during which the new method is either crushed by criticism or rises anew to take its place on a firmer foundation. Sodium morrhuate has passed its first wave of optimism and the time is now ripe to assay its true value.

My interest in this preparation was stimulated in 1930 when Higgins and Kittel published their experiences in the *Lancet*. Their claim that sodium morrhuate was slough-proof especially intrigued me, since I had been using a dye method of injection in order to avoid this complication. Accordingly, I used the new solution in practically every private and clinic case up to the present time, and herewith present an evaluation of its merits based on a detailed study of 561 injections. Altogether 1,000 injections were given, but all of these were not tabulated since it was felt that the number of treatments recorded amply bore out the claims presented.

CHEMISTRY

Originally the name "morrhuic acid" was given by Gautier and Mourgues to a nitrogenous putrefaction product, hydroxydihydropyridine butyric acid ($C_9H_{13}NO_3$) found in rotted cod liver oil. Lately the name, sodium morrhuate, has been used as an elegant synonym for cod liver oil soap prepared for intravenous injection by the methods devised by Ghosh (1920) or Cutting (1926).

In other words, sodium morrhuate is a mixture of sodium salts of the fatty acids contained in cod liver oil. To understand sodium morrhuate, one must know the composition of cod liver oil. It is a well known fact among chemists that the make-up of cod liver oil is still largely unknown. While the existence of many fatty acids has been established, others are mere conjectures, and no chemist in recent years has attempted a quantitative separation.

A partial list of these fatty acids includes: myristic, palmitic, palmitoleic, stearic, oleic, eruchic, therapic, and others too numerous to mention. Most of these are unsaturated and therefore unstable. Furthermore, the degree of unsaturation of a particular sample of oil, which of course depends upon the proportion of individual acids present in the sample, varies with each batch tested. This variation in oil depends again upon factors beyond our control, such as the feeding ground of the fish, the season of the year, and the sexual difference.

Such is the basic material from which sodium morrhuate is prepared for intravenous use in varicose veins. It is not surprising therefore that the results secured present such wide fluctuations in efficiency.

Sodium morrhuate, itself, is a yellow powder of piscine odor and greasy soapy feel. It dissolves in water to make a light yellow solution that lathers like ordinary soap on agitation. On exposure to air in solution, the mixture is unstable forming a fine white cloudy precipitate in one week. Cutting, who prepared this solution for the treatment of tuberculosis, made the claim that even in sterile amber bottles, tightly sealed, this mixture does not keep well; deterioration of the drug occurring in a week. His implication was that the efficiency of the drug for use in tuberculosis became impaired on standing. It would, therefore, follow that the chemical action of sodium morrhuate in vascular obliteration might conceivably also suffer with age.

Powdered sodium morrhuate, on the other hand, darkens on standing and becomes resinous in a few days. Even in the absence of light and moisture, deterioration takes place and an insoluble product forms. It is clear, therefore, that a solution is the better method of keeping this agent. Since oxidation is the probable factor involved in deterioration, it follows that an oxygen-free medium is the method of choice for preservation.

Thus at the very outset, one is faced with the discouraging thought that the agent under investigation has an unknown variable composition, and that its stability is difficult or impossible to maintain.

It has been claimed that sodium morrhuate is a close approach to the ideal varicose vein solution. Before we decide whether it merits this distinction let us study the postulates for an ideal solution.

[1]From the Varicose Vein Clinic of the German Polyclinic.

TABLE I

	Product A		Product B				Product C		Product D	
	NaM-½ per cent phenol		NaM-5 per cent benzyl alcohol				NaM-unadulterated		NaM-½ p er cent phenol	
			1st batch		2nd batch					
	Cases	Per cent	Cases	Per cent	Cases	P er cent	Cases	Per cent	Cases	Per cent
Very good result	0	0	30	16	0	0	0	0	0	0
Good result	21	25	81	45	39	52	81	54	33	55
Fair result	18	18	36	20	3	4	12	8	6	10
Slight result	15	15	18	10	9	12	33	22	3	5
No result	42	43	15	8	24	42	24	16	18	30
Total No. injections	96		180		75		150		60	
Successful injections	39	40	147	81	42	56	93	62	39	68
Unsuccessful injections	57	60	33	19	33	44	57	38	21	35

NaM=sodium morrhuate

REQUIREMENTS OF AN IDEAL SOLUTION

The ideal varicose vein obliterating agent should have the following characteristics:

1. Incapability of slough formation;
2. Freedom from pain on injection;
3. Efficiency as an endothelial irritant;
4. Non-toxicity in reasonable amounts;
5. Purity and standardization of constituents.

None of the solutions previously in use answered these requirements. The following study was made in order to determine whether sodium morrhuate fulfills these demands.

RESULTS OF SERIES

Table I represents a summary of 561 injections. Four preparations were studied. Their composition was as follows: Product A was a 5 per cent solution of sodium morrhuate with ½ per cent phenol; Product B was 5 per cent sodium morrhuate with 5 per cent benzyl alcohol added; Product C was 5 per cent sodium morrhuate without any adulterant; Product D was again 5 per cent sodium morrhuate with ½ per cent phenol.

The sources of these preparations were the following: Product A was made by an American firm that imported powdered sodium morrhuate from England and subsequently dissolved it in water with the addition of ½ per cent phenol; Products B and C represented American preparations manufactured in one operation at the same plant; Product D was made in England, and the finished product distributed in America.

The effects of the medication were indicated by five headings, depending upon the severity of reaction produced. These headings were arbitrarily designated as follows; "very good result," "good result," "fair result," "slight result," and "no result." The designation, "very good result" was given to a spreading periphlebitis accompanied by œdema, pain, and disability. A "good result" was defined as a firm tender thrombosis, attended by a moderate degree of pain and slight periphlebitic involvement. A "fair result" was classified as a definite thrombosis without spreading or discomfort. A "slight result" was noted if the thrombosis was incomplete. The classification, "no result" is obvious.

This rough division proved sufficient for our study, although it must be admitted that there was no sharp dividing line between the types of reaction produced.

The technique employed in this study was uniform throughout. The injections were made with the patient in the standing position and no tourniquets were used. All cases of phlebitis were excluded in order that the vascular reactions obtained should be dependent only upon chemical irritation. In regard to dosage, the vast majority of injections were in 2 cubic centimeters quantities, except for those cases discussed below.

Product A (sodium morrhuate with ½ per cent phenol) was used in 96 injections. As can be seen in the table, varying grades of reaction were secured. Practically speaking only 43 per cent or less than half of the injections made were efficient from a clinical standpoint. These poor results were particularly significant since the ampules secured were fresh and used almost immediately. This preparation was never used again since it was definitely felt that a solution made from an imported powder was inferior in quality.

Product B (sodium morrhuate with benzyl alcohol) was studied in two parts because two different batches of sodium morrhuate from the same source were tested against each other. The first batch consisted of a shipment of ampules

which was used for 180 injections. From the second batch, 75 injections were made.

Among the reactions produced by the first shipment of ampules, 30 injections were labeled, "very good result;" 15 of these reactions were attributed to high dosage, namely 5 cubic centimeters of solution. The 15 others could not be accounted for by massive dosage since no more than 2 cubic centimeters was used. Eighteen per cent of the treatments were failures. Altogether, 81 per cent of the injections in this group gave definite thromboses and did not need repetition. These variable results showed how inconsistent sodium morrhuate was in its action. In fact, different degrees of irritation were secured on the same leg of the same patient at succeeding intervals. It should also be noted that this group of ampules produced the highest percentage of successful injections in our study.

There were no severe reactions produced from the second shipment of ampules of Product B. Briefly, 56 per cent were clinical successes and 44 per cent failures. When this result is contrasted with the 81 per cent of successful "takes" in the first batch from the same manufacturer, it is evident that there is a definite variability as to the potency of the different shipments from the same source.

With Product C, which consisted of unadulterated sodium morrhuate solution, 150 injections were made. This solution came from the same source as Product B. It was made at my request in order to determine the advisability of using sodium morrhuate in a pure form. It took 4 months to complete these 150 injections. However, at the end of this time only a few ampules showed the characteristic whitish flocculent precipitate indicative of chemical changes. The number of decomposed ampules in this group was, however, no greater than occurred with the ampules containing benzyl alcohol.

The amount of local pain at the site of injection was tabulated in each case and again it was noted that there was no difference between this preparation and the one with benzyl alcohol. There were a few cases of perivascular injections in this group which were easily detected because of the immediate, sharp, burning pain produced. This danger signal was less intense in the solutions adulterated by local anæsthetics. The operator was thus better able to detect his mistake and rectify it. According to this experience, it is felt that the addition of benzyl alcohol or phenol is inadvisable as a local anæsthetic. Furthermore, the toxic effect of these adulterants must not be lost sight of especially where large or oft-repeated smaller injections are made. In regard to the thrombotic efficiency of unadulterated morrhuate solution, the table shows 62 per cent of successful results. There was evidently no loss of efficiency when local anæsthetics were excluded from the mixture.

Product D (sodium morrhuate with ½ per cent phenol) can be dismissed rapidly with the observation that this English product did not differ from the American preparation.

A general observation made on all the products tested was that the percentage of "good" or "fair results" decreased in rough proportion to the age of the ampule. With each preparation tested it was noted that the first few dozen gave the promptest and most efficient reactions. The cases labeled, "slight" or "no result" were always in greater number toward the end of each series.

In all, ten extravascular accidents occurred. Of these, two sloughs developed. One occurred in an area of poor tissue resistance near the site of an old healed ulcer. The other took place after the injection of 3½ cubic centimeters of sodium morrhuate into the thigh in an attempt to obliterate the great saphenous vein. These sloughs were preceded by the characteristic bleb formation and their subsequent course was as usual. Thus, sodium morrhuate can definitely cause slough formation although with much less frequency than the other varicose vein irritants.

I did not encounter the complication of skin eruption at any time. Dr. W. M. Cooper, in a personal communication, reports the occasional occurrence of a mild to moderate dermatitis with annoying pruritis. He states that this is a transitory reaction and can be ameliorated with the usual antipruritic lotions. In his opinion, the use of large quantities of solution, namely 10 cubic centimeters or more, was responsible for the cases of skin eruption he saw. Since I have never used over 5 cubic centimeters, this complication is unknown to me.

The above study would indicate that phenol or benzyl alcohol is unnecessary as a local anæsthetic. The absence of deterioration in the unadulterated sodium morrhuate ampules indicates that the employment of these agents as a chemical preservative in also unwarranted. However, the advisability of including these adulterants in the mixture for their antiseptic action is a debatable question.

In a personal communication from one of the first users of sodium morrhuate for vein therapy, Dr. T. T. Higgins states his agreement that the addition of a local anæsthetic is unnecessary.

However, in regard to the addition of an antiseptic, he writes:

> I have been guided entirely by the chemists and have always understood from them that it is advisable to add to the solution a trace of antiseptic like 0.3 per cent trikresol. This addition is advisable, I understand, to prevent a possibility of bacterial growth and not to prevent chemical decomposition.

A letter to an American manufacturer of ampules brought the following reply:

> I have been making preparations of this character for the past 20 years and have never felt it necessary to add preservatives, such as phenol or benzyl alcohol to intravenous solutions. We avoid the need of preservatives by extreme care in the preparation of our solutions and careful sterilization of the sealed ampules.

An inquiry directed to the manufacturer of one of the products tested in this study brought this response:

> As mentioned in our previous correspondence, Kilbourne in his recent paper stated the fact that sodium morrhuate is not self-sterilizing. As a matter of fact, the English were the first ones to use sodium morrhuate as an obliterative agent and they had ½ per cent phenol in their solution, undoubtedly for the same reason. Phenol is very toxic and is a blood coagulant; benzyl alcohol is of low toxicity, does not coagulate the blood, and is not an alcohol of the type of methyl or ethyl alcohol.
>
> As to the process of manufacture, we use a modification of R. A. Cutting's method, published, June, 1926. The preparation of the ampule solution does not differ from any of our usual ampule preparations, in so far that it is filtered under sterile conditions and filled into sterile ampules which have been sealed and sterilized.
>
> Since the sealed ampules of sodium morrhuate are sterile, the addition of benzyl alcohol is not necessary as long as the ampule remains sealed.

There is thus a diversity of opinion as to whether an antiseptic is necessary to keep the solution sterile. Since it has been shown that pure unadulterated sodium morrhuate is the better preparation therapeutically, it is certain that if it can be prepared in a sterile manner without the use of antiseptics, this method should be encouraged. It is equally certain that more study on this question is necessary.

Summing up the results of the series, the following points may be enumerated:

DISADVANTAGES OF SODIUM MORRHUATE

1. Sodium morrhuate is not of uniform chemical composition.
2. It is not uniform in its therapeutic action.
3. It is not completely stable in solution.
4. Its potency diminishes with age.
5. The use of local anæsthetics in the mixture is unnecessary and unadvisable.
6. It is capable of slough formation on perivascular injection.
7. There is some question as to whether it can be prepared aseptically without the use of antiseptics.

ADVANTAGES OF SODIUM MORRHUATE

1. Non-toxicity in therapeutic amounts.
2. A relatively small percentage of sloughs follow its use.
3. Little local pain.

These conclusions apparently point unfavorably toward the continued use of sodium morrhuate in its present form. Yet, curiously enough the writer is of the opinion that from this haphazard mixture an ideal solution can be developed. This can only be done by the isolation in pure form of the active ingredients in the combination. The author has begun this task but needless to say has only scratched the surface; much more work remains to be completed.

Before going into a discussion of the purification of sodium morrhuate, the mode of action of this agent must be explained. Many suggestions have been offered as to why sodium morrhuate is effective but none was satisfactorily understood. The best explanation has been that this cod liver oil soap irritates by virtue of its low surface tension action, which is part of its "soap effect."

To prove this point the author prepared a sterile solution of ordinary commercial liquid soap. This diluted sterile solution, which is also a mixture of unsaturated fatty acid salts, was injected into the central vein of the ears of two rabbits. In two days, a typical firm thrombosis occurred in each case just as with sodium morrhuate in the human subject. This indicates that apparently other soap solutions can cause endothelial irritation. Therefore, sodium morrhuate does not produce its effect on account of any characteristic peculiar to it alone. In other words, it should be possible to prepare a pure and known fatty acid salt solution which will have the advantages and none of the disadvantages of sodium morrhuate. The final perfected product might conceivably contain only one purified salt, or it might be a mixture of the most effective, combined advantageously.

That this is not mere hypothesis was shown by the following experiment:

A 5 per cent solution of sodium oleate, which is one of the chief constituents of sodium morrhuate, was secured from the Crookes' Laboratories. Toxicity tests were performed by the intraperitoneal injection of 10 rabbits, weighing about 2 pounds apiece. The amounts used ranged from 1 to 10 cubic centimeters. Eight animals received up to 5 cubic centimeters and 2 rabbits,

10 cubic centimeters each. The two rabbits receiving the 10 cubic centimeters dose developed diarrhœa and became moribund in 4 days. The 8 other rabbits showed no ill effects.

Based upon this observation which confirms work done elsewhere, 10 clinical tests were cautiously made upon the human subject. These patients were treated by the intravenous injection of 1 to 2 cubic centimeters of 5 per cent sodium oleate and the results noted. It was found that definite firm thromboses comparable to those secured with sodium morrhuate were obtained in 8 cases. Two patients showed no response. Thus, we duplicated the effects of sodium morrhuate by the use of one of its chief fatty acid salts.

It is not inconceivable that some of the other fatty acid salts present in sodium morrhuate would achieve the same results. The continued study of the action of these other salts would enable us to pick out the most efficient. Finally, a known definite preparation could be evolved which would represent the "morrhuate" action in an unvarying form.

CONCLUSIONS

1. Sodium morrhuate is an unknown, relatively unstable mixture of sodium salts of the unsaturated fatty acids found in cod liver oil.

2. Its potency diminishes with age, and is not uniform.

3. It is occasionally capable of slough formation.

4. No local anæsthetic should be added to the mixture.

5. The advisability of incorporating an antiseptic in the solution is open to question.

6. The irritating effect of sodium morrhuate is due to its soapy characteristics, and has been duplicated experimentally by a solution of commercial liquid soap.

7. Sodium oleate, which is one of the fatty acid salts present in sodium morrhuate has been tested and found to possess sclerotic power.

8. The continued testing of the other fatty acid salts present in the mixture is necessary if a standardized pure product is to be developed.

BIBLIOGRAPHY

1. Biegeleisen, Hyman. Slough prevention in the injection treatment of varicose veins by a new dye method. Am. J. Surg., 1932, xvi, 441–443.
2. Cutting, R. A. J. Lab. & Clin. Med., 1926, xi, 842–845.
3. Gautier, A., and Mourgues, L. Compt. rend. Acad. d. sc., Par., 1888, cvii, 110–112.
4. Ghosh, S. Indian J. M. Research, 1920, viii, 211–215.
5. Higgins, T. T., and Kittel, P. B. Injection treatment with sodium morrhuate. Lancet, 1930, i, 68–69.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D.....Managing Editor
ALLEN B. KANAVEL, M.D.....Associate Editor
LOYAL DAVIS, M.D.....Associate Editor

DONALD C. BALFOUR, M.D.....Associate, Editorial Staff

NOVEMBER, 1933

MORALE

THE soldier in the trenches, exposed to the onslaughts of the enemy is likely to look upon the outcome of any battle with a rather limited viewpoint. In case the local action directly on his front is going well, he may become optimistic about the situation all along the battle line. If, on the other hand, his front is hard pressed, a pessimistic attitude is bound to be his. He cannot understand the policy of a high command which allows such a difficult situation to exist. Consequently his faith is shaken and his morale is at a very low point.

The surgeon in his daily struggle against cancer is in much the same position. He is up against a relentless enemy, constantly on the alert to take advantage of any break in his favor. Many times the operator is thrown into the action merely to make a demonstration against a strongly advancing force, to fight a delaying action. It is not surprising, therefore, that occasionally the surgeon loses heart and thinks that the battle is lost all along the line. At times he even goes so far as to admit that he is always in a losing fight when this enemy cancer is his opponent.

The man on the firing line should realize, however, that back of the front efforts are being made which compare very favorably with his own. Ammunition is constantly being provided to supply him for the continuation of the battle. The higher command is repeatedly fighting over the engagement in miniature (on experimental animals), trying out new weapons which may at any time be rushed up to the front for his use. New engines of destruction are being invented to be let loose in an unexpected attack on the opposition. New plans are proposed, tried out, and rejected if they do not offer promise. There is, perhaps, a real need for a more unified command but as yet no outstanding commander, capable of assuming this position, has appeared. The soldier in this campaign should also remember that whereas on his own front the battle seems to be all against him, on other parts of the line there have been successes, local victories of consequence. That the fight is not altogether hopeless is evident when at a reunion of veterans their past victories are recalled.[1] The surgeon owes it to his colleagues and to the civilian population who depend upon him, to rid himself of the pessimistic attitude. He must brace up the morale of the whole population or else the battle will indeed be lost. In no other war has it ever been more necessary for the fighting man "to travel hopefully" in the words of Stevenson, than in this conflict against the scourge of mankind—cancer.

JOHN J. MORTON.

[1] Symposium on Cancer. Surg., Gynec. & Obst., 1933, lvi, 412-475.

THE CHANGING ATTITUDE TOWARD ILEUS

WHEN first seen by the surgeon the patient with ileus presents a picture often complex, though a clue as to the origin of the condition can frequently be obtained from a history of similar attacks of less severity, of previous intra-abdominal infection, or of a more or less remote abdominal operation. These facts may imply the probability that the ileus had its inception as a mechanical obstruction. On the other hand, the occurrence of ileus during a hospital stay following an abdominal operation is ordinarily started by segmental paralysis of the intestine adjacent to residual infection or, less commonly, to knuckling or twisting of a loop by an adhesion which has not yet gone through the full process of absorption. Regardless of the original mechanism of interference with gastro-intestinal function at any given level, the picture of full blown ileus becomes the same for all cases, since distention itself leads to loss of tonus of the intestine. It is at this point that, until recent years, our knowledge of the physiological derangement of ileus stopped short. As in other fields of medical investigation, research on the ultimate cause of death led first to a fuller understanding of the chemical, as opposed to the physiological, imbalance. Even now the fact that obstruction itself is not the cause of death is not fully appreciated although replacement therapy with the provision of water, sodium chloride, and calories has become generally practiced as adjuvant treatment.

Emphasis is now being placed on certain important factors which have been widely disregarded and new facts have been added to our knowledge of the mechanism of the development of, and recovery from, ileus. While it has long been recognized that the paralyzed loop of gut lying next to, and perhaps forming the wall of, an abscess acts like a mechanical obstruction to the intestine, only recently is the view gaining acceptance that the final factors in mechanical obstruction are usually œdema and spasm of the gut itself. That is to say, patients who have a chronic incomplete obstruction are thrown into a state of acute, more or less complete obstruction by gross indiscretions in diet, abuse of cathartics, and similar indiscretions. There is ample evidence that the œdema and spasm at the site of obstruction accountable for the acute stage need be only temporary, for on no other basis can the history of previous obstruction crises with spontaneous recovery or recovery after enterostomy be explained. The prime necessity is obviously twofold: (1) to empty and to keep continuously empty the obstructed intestine of fluid and gas in order that structural damage to the bowel wall may be avoided, tonus recovered, and spasm and œdema allowed to subside, and (2) the prevention of fatal chemical derangement by replacement therapy. The danger of too rapid release of distention has recently been suggested by studies on intra-intestinal pressure, from which it appears that absorption through the distended intestine is practically nil due to the decrease in venous and lymphatic drainage but that it may quickly increase if distention is suddenly released. The evidence is not yet conclusive but appears to support similar clinical observation on fatalities subsequent to enterostomy.

Using a modification of the apparatus for continuous suction from the stomach first described by Robertson Ward in 1929, we have made observations for more than 2 years on the early events in the development and subsidence of ileus, including cases having their origin in mechanical obstruction. Not only does the apparatus decompress the intestine

gradually and keep the obstructed gut effectively emptied but it provides a means whereby one can study the variations in the physiological status of the intestine in ileus by measuring the rate of flow of secretion from the intestine into the stomach, which is demonstrably increased at any time by stopping the suction temporarily and by allowing the patient to drink. Continuation of suction results in a progressive diminishing of this flow until a standstill is reached and only ingested fluid, and no more, is recovered by suction. After varying periods, depending on the origin of the ileus (infection or mechanical obstruction), the flow of ingested fluid moves through the pylorus in progressively larger percentages and at an increasing rate. We measure the flow in terms of cubic centimeters per hour and can thus chart graphically the direction and rate of flow per unit of time. We have termed this the *pyloric balance* and speak of it as being negative when the gut is emptying itself into the stomach and positive when the stomach is emptying ingested fluids into the gut. We have also found that after peristalsis has disappeared tonus is retained to a degree that permits recovery of normal gastrointestinal function on this regimen. Peristalsis, audible to prolonged auscultation, reappears only after obvious restoration of the physiological continuity of the gut.

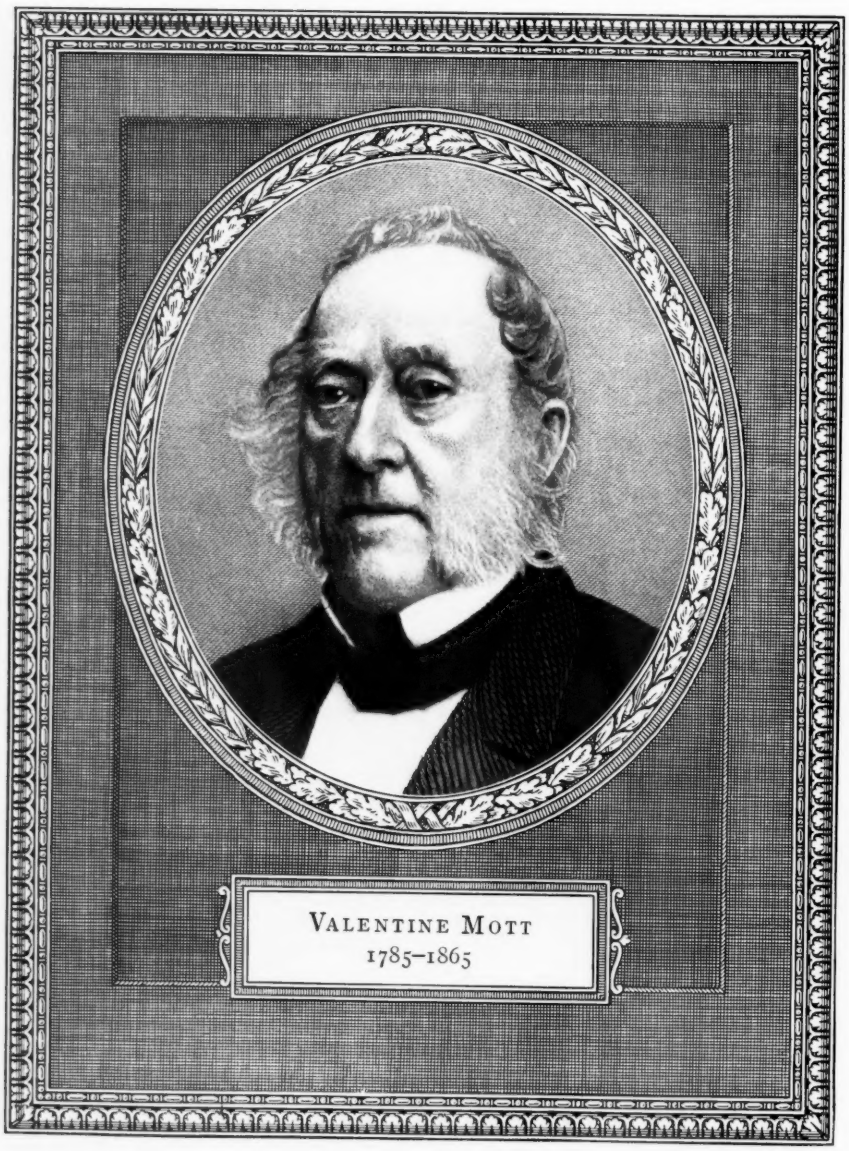
Early operation for intestinal obstruction has traditionally been urged and when the case comes to the surgeon within a very few hours of onset a mortality of as low as 5 per cent has been reported. In only rare instances is a surgeon able to report any considerable series of cases seen at such a time by himself. The entirely praiseworthy effort to urge early operation has had the effect, not of stimulating the physician in general to get the patient to the hospital as soon as possible but of inducing the surgeon to operate as soon as the operating room can be got ready after the patient enters the hospital, regardless of how long the obstruction has been present, regardless of the probable site and nature of the original lesion, regardless of the physiological status of the intestine, and as well the chemical and metabolic status of the patient. It is probably fair to say that a single gastric lavage and an intravenous injection of physiological salt and glucose solution represent the average of good pre-operative treatment. The inevitable result of such treatment, however, is the publication of mortality statistics of from 40 to 60 per cent in all large series of cases, year in and year out, collected from many large general hospitals.

Primary suture after resection of obstructed, gangrenous intestine is now almost universally condemned but is still practiced not uncommonly. With exploration being done in an overwhelming majority of patients with ileus in the fear that gangrene may have set in, the result is approximately half of those who undergo operation die whereas gangrenous gut is found in less than 5 per cent of cases, excluding those with external hernias. The confusion in reasoning is obvious. There is an increasing number of surgeons to whom it is clear that, in view of the newer facts of the physiology of ileus, the patient, unless seen very early, is safest on decompression and replacement therapy with close observation of the pyloric balance until it is at least no longer grossly negative. Then, if necessary, operation may be performed with the patient in approximately a normal physiological status but operation may actually be unnecessary unless the original obstructing mechanism be a stricture, if mechanical, or a definite abscess demanding drainage, if infectious in nature. The plan of decompression is only temporarily practicable in cases with very high obstruction, due to the enormous

outpouring of high intestinal secretions, and in those obstructions in the colon in which the ileocæcal valve is competent (which is not often the case, in our own experience); however, cases of external hernia are, naturally, excluded.

As series of cases sufficiently large to be significant are accumulated, it is our belief that a reduction in the mortality from ileus will have been accomplished for the first time in the past quarter of a century.

WILLARD BARTLETT, JR.



VALENTINE MOTT
1785–1865

UNIV. OF WISC.

MASTER SURGEONS OF AMERICA

VALENTINE MOTT

A BRILLIANT and ingenious colonial surgeon of Quaker descent, son of a physician, and father of an eminent surgeon, Valentine Mott was born in Glen Cove, Long Island, August 20, 1785. Reared in an atmosphere of medical science, he readily adopted the avocation of his forbears and soon attained international fame for his surgical skill and clinical wisdom. Completing his classical education under the guidance of private tutors at the age of nineteen years, he embarked on his medical studies at Columbia College, which institution conferred on him two years later, in 1806, his medical degree.

Desirous of more advanced surgical training, Mott continued his studies abroad, and first placed himself under the tutelage of Sir Astley Cooper. After remaining for some time in London, he journeyed to Edinburgh and, for more than a year, attended the lectures and demonstrations in surgery and surgical anatomy in this center of medical learning. Five years from the time he enrolled in Columbia College as a medical student, he returned to New York and established himself in the practice of surgery.

In 1810, the year after his return, he accepted the chair of surgery in his alma mater, Columbia College, which he retained for three years until the school was reorganized and the College of Physicians and Surgeons founded. He continued his professorial duties in this new institution without interruption until 1826. At this time discord arose among the faculty members and Mott, with a few of his colleagues, founded a new medical school in connection with Rutgers College. Unfortunate legal difficulties forced him to abandon this project, however, and in 1830 he returned to the College of Physicians and Surgeons as professor of operative surgery and surgical and pathological anatomy. His life was unusually active and useful until 1835, when waning health caused him temporarily to abandon his duties. The subsequent six years were largely devoted to European travel which included close attendance to many of the most famous surgical clinics on the continent. By this time Mott enjoyed a wide reputation as an astute and able surgeon, particularly eminent for his original work in the field of vascular surgery. Completely restored to health, he returned to New York in 1841 to become the principal founder of New York

University Medical College, in which institution he filled the chair of surgery and relative anatomy as well as being president of the faculty. At the age of sixty-seven years he was made emeritus professor lecturing to the students occasionally until his death from angina pectoris, thirteen years later, April 26, 1865.

Characteristic of all pioneers who venture into unexplored fields, Valentine Mott was a bold, though careful operator with an imaginative and intuitive mind, and possessed of unusual technical skill. Handicapped during most of his life by the difficulties and dangers attending surgical maneuvers prior to the discovery of ether and the development of bacteriology, his operative innovations were, of necessity, largely limited to rapidly performed procedures which did not necessitate entry into the abdomen. During his later years, however, the frequency and enthusiasm with which he employed ether anæsthesia aided materially in the universal acceptance of this great boon to surgical progress.

Mott's most fruitful and original work pertained to surgery of the blood vessels. His first claim to renown came at the age of thirty-three when he, for the first time, ligated the innominate artery for aneurism of the right subclavian artery. Unfortunately the patient succumbed several days later following hæmorrhage from an adjacent vessel, eroded secondarily by infection. Incidentally it was almost half a century later before this operation was successfully performed. In 1827 Valentine Mott was the first to ligate the common iliac artery for aneurism of the external iliac, placing the ligature within half an inch of the aorta. Another of his original contributions to vascular surgery was excision of several inches of the deep jugular vein which was involved in a tumor mass. This required ligation of both ends of the vein, something hitherto unattempted. He also made numerous advances in the repair of traumatic lesions of the large veins which he closed with fine sutures without occluding the lumen of the vessel. In all, he tied the common carotid artery forty-six times.

Mott's endeavors were by no means limited to surgery of the blood vessels, as he also contributed much to orthopedic and plastic surgery. In 1821 he resected the right maxillary bone for osteosarcoma, having first ligated the common carotid to prevent excessive hæmorrhage. Several years later he successfully performed an amputation at the hip joint. In 1828 he removed the right clavicle which was involved with a large sarcomatous tumor, an operation which won him considerable fame and was long known as "Mott's celebrated case." The operation required nearly four hours for its completion and in Mott's own words was the most tedious, difficult, and dangerous procedure ever undertaken by him. He was the first surgeon to devise a cure for "cleft spine," accomplished by extirpation of a tumor at the lower end of the spine. Later he performed a similar operation in the region of the neck. He was unusually adept in restor-

ing the normal contour and appearance of the cheeks, lips or nose following disfiguration incident to the excessive use of mercury.

Endowed with great physical vigor and conscientious devotion to his profession, Valentine Mott was a prodigious worker. During his entire busy and practical life he continually enlarged and refreshed his knowledge of normal and pathological anatomy by dissection and postmortem examinations despite the legal hindrance incumbent upon such practice. It is said that before each new or important operation he first tried his contemplated procedure upon the cadaver. There were few operations known in his time that he did not perform. He was one of the foremost lithotomists of his day, operating for stone 165 times with a mortality rate of less than 4 per cent. In one instance he removed a stone weighing more than seventeen ounces. He is credited with more than a thousand amputations. For fifteen years he was senior consulting surgeon to Bellevue Hospital and for varying periods served in a similar capacity for St. Lukes, the Hebrew, St. Vincents, and Women's Hospital. "His success in capital operations was due not simply to his surgical knowledge and skill, but in a large measure to his care in the after-treatment of the patient, and to a knowledge of therapeutics that brilliant operators rarely possess." Although performing, as Sir Astley Cooper said, "more of the great operations than any man living or that ever did live," he remained a staunch advocate of conservative surgery.

Mott contributed some twenty-five papers on various surgical subjects to the literature of his day. He augmented the American edition of Velpeau's *Surgical Anatomy* with many notes and illustrations from his own works. He was the recipient of numerous honors, including fellowship in the Imperial Academy of Medicine of Paris, the Medical and Chirurgical Societies of London and Brussels, the Paris Clinical Society, and Kings and Queens College of Physicians of Ireland. For many years he was president of the New York Academy of Medicine. Unfortunately, most of the valuable specimens of his anatomic museum were destroyed by fire shortly after his death. His wife succeeded in gathering the remaining ones together, however along with a large share of his library and other mementos, and established the Mott Memorial at 64 Madison Avenue, New York City. Unfortunately, this memorial is no longer in existence, although the New York Academy of Medicine became heir to the Mott Library.

JAMES T. PRIESTLEY.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE book on *The Art of Anæsthesia*[1] by Flagg, a recognized authority on general anæsthesia, has been used for 16 years. The introduction gives a brief history of anæsthesia with interesting illustrations.

This, the fifth edition, as were former ones, is in two parts: Part 1 bearing upon the classification of anæsthesia, its characteristic signs, and its administration by the various methods and agents ordinarily employed is the same as in the previous edition except a chapter on ethylene is added and the chapters on regional and spinal anæsthesia are brought up to date both as to methods and agents employed. A criticism the author makes on the use of regional and spinal anæsthesia is that "the technique is more readily acquired by the surgeon than that of general anæsthesia and as a result the one method is used to the exclusion of all others. This serves to bring the regional and spinal methods into disrepute."

Part 2 of the book treats of the factors incidental to the actual administration of the anæsthetic.

The chapters on premedication, postoperative care of the patient and carbon dioxide are unchanged, but considerable new and valuable material has been added to the chapter on the selection of the anæsthetic and the method of administration. A full new chapter is devoted to the improved technique for intratracheal anæsthesia.

The author describes the technique for intubation and tells of the complications and how to meet them. Then follows a summary of the advantages and disadvantages of intratracheal anæsthesia.

A new chapter on "Newer Methods of Artificial Respiration," lucidly describes the four methods available in cases of asphyxia or respiratory failure.

This book is an excellent text for all students of anæsthesia as well as for surgeons and internes.

MYRTLE KNOWLES.

THE publication of this volume by Bailey[2] performs the very useful service of recapitulation and bringing together into one volume not only the symptoms, the disordered histological characteristics and the treatment of intracranial neoplasms, but also considers, often in great detail, the embryology, anatomy—both human and comparative—and the physiology of the various structures within the calvaria which may be affected by these new-growths.

As would be expected from this author, the pathological changes which characterize the various types of neoplasms are admirably dealt with and afford one of the most brilliant and satisfying features of a volume which should be of great value to the medical undergraduate and the practitioner of neurology and neurological surgery.

The chapters which consider the new-growths which may arise in any of the various parts of the brain do so in connection with functional areas thus emphasizing the physiology of the cortical, subcortical, and ganglionic regions while the more specialized neoplasms such as the acoustic neurinomata, the hypophyseal adenomata, the pharyngiomata, and the pinealomata are the subjects for special chapters as are also the tumors arising from the intracranial connective tissue, the vascular structures and miscellaneous and metastatic neoplasms. In this way the author presents the more important facts connected with this most intricate system of organs without devoting any special chapter or chapters to the subject of cerebral localization and function.

The preliminary chapters deal with the general problems presented by brain tumors, the structure of the cranium and its contents, and considerations of a general physiological nature such as the circulation of the blood and the cerebrospinal fluid. General and differential diagnosis and the treatment of cranial and intracranial tumors constitute the subject matter of the concluding chapters.

Many invaluable tables, schemata, classifications, and tabulations which have appeared in scattered publications by the author and his former illustrious collaborator—Dr. Harvey Cushing—are gathered together in this volume and thus become readily accessible to the reader. The graphs representing the age distribution of intracranial tumors, of gliomata, medulloblastomata, subtentorial tumors, and gliomata above or below the tentorium are especially illuminating.

The format of the book is in the majority of features very satisfactory. The publishers and the author have elected to use a semi-rough uncoated paper which is restful to the eye and permits a volume of considerable size to be of only moderate weight but it renders impossible the use of half-tone illustrations and necessitates the use of pen and ink drawings. It cannot be said that all of these are

[1] THE ART OF ANÆSTHESIA. 5th rev. ed. By Paluel J. Flagg. Philadelphia and London: J. B. Lippincott Company, 1932.

[2] INTRACRANIAL TUMORS. By Percival Bailey. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1933.

works of art and some of them are definitely unpleasant in their execution. One would also wish for photographs of specimens—both gross and microscopic—since these always convey a greater sense of verisimilitude. The use of this kind of paper also necessitates outlines instead of prints from roentgenograms. Only a very few typographical errors have evaded the scrutiny of the proof-readers. One illustration would seem to be definitely mislabelled.

The majority of the chapters still contain—it is not clear whether intentionally or not—indications that the various subdivisions of the book have at one time or another been presented in lecture form or as clinical presentations. To the reader this is distinctly unpleasant and detracts very materially from the dignity of the publication and spoils the effect of the presentation of otherwise admirable material.

There are a number of dogmatic assertions of which any lecturer is always guilty, but which should never be allowed to find their way into a published work. These are scattered rather widely throughout the book and notice should be taken of a number of them since they would certainly seem likely to mislead the student. On page 58, in discussing lesions produced by occlusion of the middle cerebral artery, the author presents a number of definitions which may have individual supporters, but certainly have not acquired full acceptance by neurologists in general.

In discussing the well known effect of neoplasms of the pineal region in destroying the function of vertical conjugate movements of the eyes, the author states that paralysis of conjugate movement of the eyes occurs only as a result of involvement of the tectum mesencephali, ignoring the possibility of this symptom being produced by involvement of the vertical oculogyric pathway in the subthalamus. The loss of vertical gaze is an important component of the syndrome of the subthalamus also. The statement that "occlusion of the pre-rolandic artery (when on the left side) causes an intense alexia without hemianopia" may occasion some surprise.

In view of the general high excellence of the treatment of clinical phenomena and the physiology of the cortex and other parts of the brain, it is to be regretted that many theories still in a highly debatable and controversial state are too categorically and dogmatically presented.

After devoting nine pages to a critical discussion of the aphasias and in many instances making quite restricted localization for the varying types of aphasia and associated difficulties the author concludes that "in actual practice the aphasic symptoms are often deceptive and must not be relied upon for too restricted localization in cases of cerebral tumor."

Considerable space is devoted to the still largely hypothetical function of the hypothalamus and the author concludes after an extensive discussion, that there is at present no concensus in regard to these structures and that it is improbable that any attempt to assign specific functions to these nuclei will succeed. The statement that the basal regions of the brain must exert a regulating influence upon the cortex and that an anterior group of nuclei excite and another group about the superior posterior part of the third ventricle calm and quiet the cortex may be accepted with some caution.

It is a question whether the inclusion of such a mass of detail and the presentation of so many contested theories and highly debatable minutiæ does not serve to confuse the student and distract his attention from much of the most praiseworthy material which may be found in this book. The volume attempts to present the last word in regard to many topics and in this way it does not fulfill its avowed purpose of being a book adapted to the needs of the medical student, beset as he is with all of the distractions and necessities of his medical curriculum of which neurology is only one of the constituent parts. From the standpoint of the advanced student or practitioner the volume contains a mine of most valuable information gathered from many sources and made readily available, but for this type of reader, the presentation is often entirely too dogmatic and conclusions are proposed which will not be accepted by the majority of experienced workers in this field.

In presenting various syndromes of the brain-stem, use is made of individuals presenting neoplasms. This is notoriously unsafe since neoplasms of the brain-stem usually involve structures at a distance from their site and also in many instances fail to involve structures within their compass, for example—Benedict's tegmental mesencephalic syndrome is described as presenting pyramidal tract symptoms which is contrary to the strict interpretation of the syndrome and the generally accepted restriction of its localization to the tegmentum of the mesencephalon. It is fairly generally accepted that vascular lesions produce much more satisfactory brain-stem syndromes than those occasioned by the involvement of the brain-stem by tumors. In the presentation of the tumors of the hypophysis and the neighboring structures no mention is made of the results of pressure upon the brain-stem or the structures contained within the cavernous sinus. In view of the extreme detail devoted to the consideration of other regions, these omissions make for a certain degree of unevenness in the treatment of the various syndromes presented.

The chapter on the neoplasms arising in and around the floor of the third ventricle and the associated structures are perhaps the most satisfactory in the volume. The treatment of the histological features of the various tumors discussed is, as would be expected, most thorough and painstaking. This feature of the volume makes the book extremely valuable to neuropathologists, neurologists, and neurological surgeons.

The chapter on encephalic tumors in general contains a great deal of material of great value to the clinical neurologist and neurological surgeon. It is, however, again marred by many colloquial expressions and forms of speech and a number of the illus-

trations are but little more than black-board sketches, copies of which they undoubtedly are. Neither of these features contributes to a pleasant impression. The general distinctions and differences between the various neoplasms, the classifications and detailed descriptions are brief, distinct, clear, and very useful.

Chapter 18 deals with the general problems of diagnosis between brain tumor and other organic conditions of the brain. The author considers migraine and recurrent headache and the numerous processes which undermine and finally overthrow the cognitive faculties of the mind, such as repeated small cerebral insults, senile dementia, presenile dementia, cerebral arteriosclerosis, general paralysis, and cerebral syphilis. The question of generalized and focal seizures is considered in detail since these irritative manifestations are so commonly indications of the presence of a neoplasm within the brain substance, and a number of case studies are used to exemplify the problem as it is approached by the physician. Recurrent vomiting and failure of vision are examined in relation to their occurrence with other cerebral morbid processes. The author rightly emphasizes the importance of an intimate acquaintance with the ophthalmoscope and the structures made visible by its use. The commonly seen alterations in the fundus in optic neuritis, papillœdema, choked disc, nephritic hypertension and arteriosclerotic conditions are well described and the difficult distinction between optic neuritis and papillœdema made as clear as it can be. The appearance of primary and secondary optic atrophy are succinctly presented. The writer divides the neurological symptoms into three groups—(1) focal, (2) neighborhood and (3) distant, emphasizing the importance of the chronological order of development of symptoms but draws attention to the fact that neoplasms which arise in relatively silent areas may be characterized by distant symptoms arising either from an increase in general intracranial pressure or by compression of arteries supplying relatively distant areas, before focal symptoms appear. The author emphasizes the relief often occasioned by the injection of hypertonic solutions, decompression, etc., which may accomplish such an improvement in the patient's general condition that a satisfactory localizing diagnosis may be made at the neurologist's leisure.

The author correctly states that "ventriculography should be resorted to only when necessary" and deprecates the belief that this method can supersede careful neurological diagnosis. He correctly emphasizes the fact that "ventriculography does not make a diagnosis of tumor but only of distortion or displacement of the ventricles."

In the chapter on differential diagnosis between neoplasms and other pathological conditions, the writer rightly emphasizes that the diagnosis of tumor is made with the sum total of one's knowledge of neurology. The author limits his consideration in this chapter to the more usual conditions which may be confused with intracranial neoplasms and in general the presentation is adequate and helpful. The important differentiation between neoplasm, tuberculoma, gumma, abscess, both acute and chronic, parasitic disease, chronic subdural hæmatoma and aneurysm are satisfactorily considered, but the space devoted to the consideration of the encephalitides and encephalopathies is rather meager. One can perhaps wish that much of the space devoted to anatomy, physiology and disputed points in regard to symptomatology could have been devoted to a more extensive consideration of differential diagnosis. It would seem that such a course would be of greater value to the student and to the neurologist.

The chapter on the treatment of intracranial tumors and its results is relatively short but admirable—not much space is given to the technical details of the optimum incision and approach but the general principles of intracranial technique and the postoperative management of the patient are excellently presented. The author stresses the importance of the proper handling of the three most feared postoperative complications—hæmorrhage, shock, and respiratory paralysis, explaining clearly and describing definitely the procedures to be followed. The surgical principles are presented simply and convincingly.

In preparing this volume one can well admire the herculean task which the author has attempted and in general the admirable results which he has obtained. The balance of the book, when viewed from the standpoint established by the author of bringing forth a volume which will be read by the medical undergraduate, may, however, be criticized. In many instances material which can adequately be grasped only by one already highly trained in neurology has been poured forth with a prodigal hand before an audience which has neither the background nor the perspective to appreciate it. Such prodigality may lead to too early satiety and many of the innumerable excellencies of the volume will therefore fail to reach the author's consuming public.

In the form of the volume and the manner of presentation one can perhaps differ and still remain friends as to what is most desirable, but in the reviewer's mind there lurks the suspicion that the too easy method of combining groups of lectures into a book has been followed and that the very necessary drudgery of manuscript and proof reading and rereading has been begrudged by the author to the very evident injury of the style and dignity of presentation. The decision as to the proper amount of nectar and ambrosia to be set before the undergraduate is always a difficult decision to make, but in general it is better to whet the appetite for more than to kill the zest with a superfluity of viands.

There is so much in the volume to make it a mine of information and so invaluable a recourse for the student, neurologist, neuropathologist, and neurological surgeon, that the reviewer has taken the liberty of going perhaps more into detail than he should, with the purpose that future editions may appear without many details which militate against the self-evident value and usefulness of the volume.

HENRY ALSOP RILEY.